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Samuel Slater Memorial Textile Research Laboratory

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THE Samuel Slater Memorial Laboratory established at Massachusetts Institute of Technology, the dedication of which was announced January 3, 1945, will, because of its unique electronic equipment, pioneer in textile research as Samuel Slater pioneered in textile manufacturing when he built the first cotton card and spinning frames in 1790 and established the first cotton mill in the country at Pawtucket, Rhode Island. One hundred and sixty-five years later, the Samuel Slater Memorial Research Laboratory takes up the problems associated with the load-deformation-time-temperature and humidity relationship in fibers, yarns, and fabrics by means of new apparatus involving the application of electric strain gages, high-speed photography, and the use of such modern devices as the oscillograph and the photoelectric potentiometer recorder.

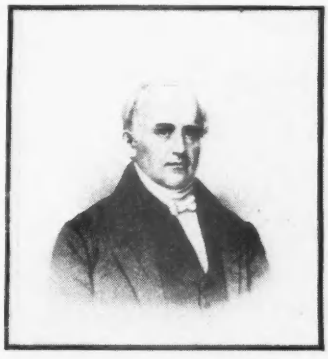

FIG. 1. *Samuel Slater.*

With this equipment, it now becomes possible to apply to a textile specimen a load of a fraction of a gram for periods of many hours and to record the resulting deformation or to apply many hundreds of pounds to the specimen in less than 0.001 second, still recording precisely the load-deformation behavior.

For this latter work, impact testers have been constructed in which either a 25-pound weight or a 500-pound weight can be allowed to fall from a height of many feet to cause failure of the sample under shock load. The sample is held by standard jaws in series with a weight bar. The weight is designed to pass by the weigh bar, upper jaw, and sample, and to pick up and to carry along with it the lower jaw, thus extending the sample to rupture at the velocity of the weight. This assures a substantially constant rate of stretch for the sample and makes the result of the test directly comparable with others which can be conducted at a constant rate of deformation but at very much slower speed.

Attached to the weigh bar is an electric strain gage, the resistance of which is proportional to the load applied to the specimen. The varying voltage across the strain gage is amplified and fed into a standard oscillograph. Here the electron beam, producing a small spot on the fluorescent screen of the

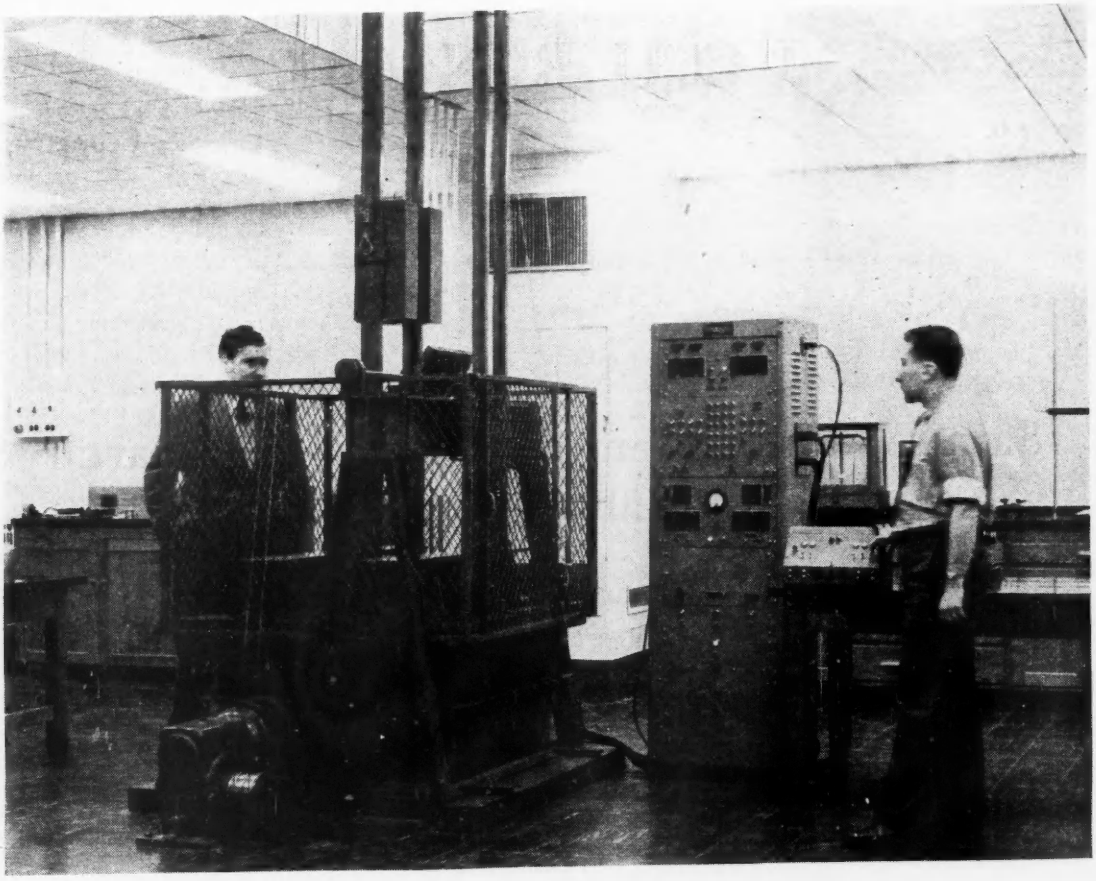

FIG. 2. *Slater Impact Tester, showing control and operating cabinets.*

FIG. 3. *Electronic compressional resilience tester.*

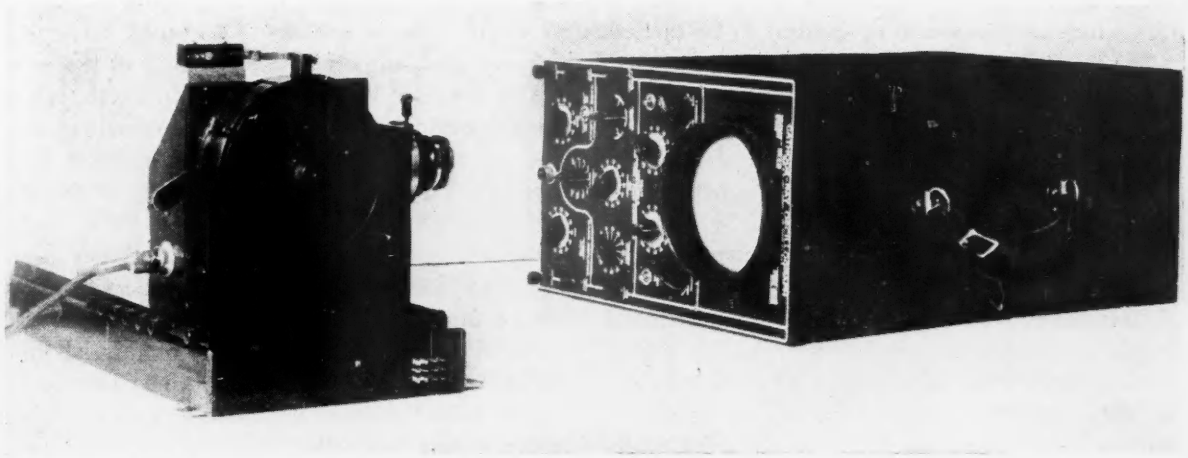

FIG. 4. *High-speed camera and oscillograph for recording impact tests.*

oscillograph, is deflected by the action of the signal from the amplifier and causes the spot to move across the screen a distance directly proportional to the load applied to the specimen. The spot deflection on the oscillograph screen is recorded by a special high-speed camera. This carries a strip of highly sensitive film on a rapidly rotating drum. The spot deflection of the oscillograph is in a horizontal direction and the film in the camera is rotating in a vertical plane. Thus the motion of the oscillograph spot is spread over a portion of the length of the film strip, the actual distance depending on the duration of the test. For intervals of less than 0.01 second, the diagram photographed on the film may be several inches long and possibly ½ to ¾ inch in height. For convenient study the film can be projected against the screen or enlarged photographically. In any case, while strictly representing variation of strain-gage-voltage with time, it also is evidently equally representative of load versus extension for the sample.

The recording control cabinet houses a specially designed amplifier, power pack, and a voltage stabilizer. It also contains means for calibration so that each record will carry a calibration line and a base line for any range of load at which it is desired to operate. Another section of the cabinet provides for a control panel and for electronic time-interval switches to insure clear records over the extremely brief periods of tests. The operation controls comprise a bank of 37 relays and a set of panel lights which insure proper sequence and completeness of all necessary procedures for a perfect recording of as many as 15 diagrams per film.

The camera which does the recording is mounted on a base containing a series of micro-contact switches to allow its positioning so as to photograph either the oscillograph screen at a number of different angles or a panel carrying numbers, any one of which may be selected and illuminated for the correct time of exposure, in order to number the film for identification. The circuits of the control cabinet are ingeniously arranged so that sequence relays essentially "remember" completed operations and give a warning signal if there is any improper adjustment.

For example, if the camera is ready to photograph the illuminated number only a blur would be obtained were the motor-driven film drum rotating at the time. Any attempt to open the camera shutter will therefore give a warning signal. On the other hand, if the drum is not moving when the camera faces the oscillograph screen, a warning signal is given upon attempting to open the shutter because, in this state, a record would not be obtained. A further precaution is taken to prevent fogging of the sensitive emulsion when the shutter is open. The cam-operated circuit shuts off the room lights for a period slightly in excess of the exposure time. The operation panel is arranged to indicate by means of colored lights which positions of the camera have been utilized and whether the record has been properly calibrated and a base line drawn. When the warning signa' sounds, a glance at the panel serves to determine by means

of words appearing in red letters in appropriate indicators which of the operations remain to be carried out.

All satisfactorily completed operations are similarly indicated in green.

Both weights can be held at the top of their respective guides by powerful electromagnets. The small weight can be raised and lowered by hand by means of cords and pulleys but the 500-pound weight must be lifted by means of a motor-driven winch and steel cables. The machine is protected by metal wire guards with electromagnetically locked sliding panels. The interior of the machine is thus accessible only when the weights are resting in a safe position. This guard system is operated by interlocking relays, housed in a small cabinet. Push-button controls raise and lower the weight and control the action of the magnet.

The large weight is capable of delivering more than 1,000 tons per square foot on the floor if dropped directly. Therefore a shock absorber, weighing approximately 3 tons, forms the base of the entire machine. A set of 36 tuned, coil springs of heavy steel support an inertia block of lead which weighs 2 tons. When the weight falls, the springs are compressed, allowing sufficient movement of the block to absorb the energy transmitted to it by the weight. A recess is provided to receive the lower jaw so that it will not be crushed. The load capacity of the Slater Impact Tester ranges from 1 pound to 5,000 pounds and will handle yarns, cordage, or fabrics.

For the duration, the facilities of this laboratory are being used in work for the Armed Forces.

The Slater Memorial Laboratory is maintained under closely controlled conditions of relative humidity and temperature by means of humidifying, heating, and refrigeration systems. It is equipped with the latest design of laboratory furniture and accessories and is an active and continuing memorial to a great textile pioneer and a fitting tribute in these times to the genius of Samuel Slater.

Announcement

The name of this journal has been changed from "Textile Research" to TEXTILE RESEARCH JOURNAL, and the new title appears for the first time on the cover and the masthead of this issue. This title retains the advantage of easy reference and citation.

At a recent meeting of the board of directors of the Institute it was decided to make the JOURNAL available to subscription from any source—non-members as well as members. The subscription rates are given on the contents page.

Sizing of Spun Viscose Warp Yarns

III. Application of Synthesize, a Thermoplastic Abietic Acid Ester

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One of the projects in the program of research on the subject of warp sizing which was organized and administered by Textile Research Institute, Inc., comprised a study of the sizing of warp yarns constructed from spun viscose rayon. The papers in the series now being presented in this journal cover certain parts of a project carried out during the period from October, 1940, through November, 1942. In accordance with an agreement between the Institute and the sponsors of the project these papers have not been published previously. Part I—"Effect of Stretch in Slashing," and Part II—"Abrasion Testing of Sized Warp Yarns," appeared in the January issue of this year. Parts III and IV in this issue cover Confidential Reports Nos. 7 and 8 respectively. Part V—"Application of Corn Starch Ether Gum and Its Removal from Fabric," will conclude the series and is scheduled for the March issue. A comprehensive summary of this project, including the recently concluded project, has been prepared and will be published at an early date as an Institute report.

THE practice of processing fabrics made from staple fiber with synthetic resinous materials has grown in importance during the past decade. These treatments have been applied chiefly with the object of altering the physical nature of the fiber and fabric. An example is the familiar urea-formaldehyde process whereby a more or less permanent anticrease finish is achieved by fixation of a non-soluble resin upon or within the fiber to improve its ability to hold its shape.

The difficulty experienced in finding sizing materials which would form a satisfactory bond or become tenaciously fixed to the relatively smooth synthetic fibers in warp yarns gave impetus to investigations into the possibilities of synthetic resinous materials in warp sizing.

The application of a true synthetic resin as a warp-sizing agent is, of course, practical only when complete removal of the size is not required. In certain types of fabrics the resin content of the size is allowed to remain and contribute to the finish of the fabric.

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Summary

The application of Synthesize, a thermoplastic abietic acid ester, as an assistant to tapioca gum in spun viscose warp sizing was investigated. The preparation contained 42.6 percent solids. The ester was modified with a non-drying oil and emulsified with an amine soap. The preparation so modified was reduced in tackiness and took on desirable lubricating properties. Yarns sized with tapioca gum alone were compared with similar yarns sized with mixtures containing 8 pounds of emulsion per 100 pounds of gum and 25 pounds of emulsion per 100 pounds of gum.

The addition of the emulsion to the size did not improve the breaking strength of the yarn but did decrease the abrasion resistance of the warp. However, it increased the residual elongation of the yarn, reduced the shedding of fiber from the warp in weav-

TABLE I. Viscosity of size, size distribution on yarns, and shedding of fiber from yarns in weaving

Test No.	Viscosity	Size distribution	Shedding
21	4.00	Coating and penetration	High
22	4.25	Penetration	Medium
23	4.62	Coating	Low

ing, and reduced the loom stops per 8 hours of weaving from 8.27 to 7.44 with the addition of 8 percent of emulsion, and to 4.75 with the addition of 25 percent of resin emulsion.

All fabrics woven from warps sized with mixtures containing the emulsion were tinted slightly yellow. Ageing of the grey goods in an oven for 200 hours at 160°F caused a rather pronounced yellow cast to develop, but no difficulty was experienced in size removal from fabrics subjected to ageing tests.

Tensile tests performed on the fabric both before and after ageing showed no loss in tensile properties for the cloth sized with tapioca gum alone, but revealed a loss in tensile strength for the cloths containing Synthesize, indicating some deterioration of the fiber due to the presence of the sizing material.

It should be emphasized at this point that the product tested was not a true resin but a water-dispersible ester capable of complete removal. The product is described as a thermoplastic abietic acid ester modified with a non-drying oil to reduce tackiness and held in suspension in water with amine soap. The emulsion is easily miscible in water and contains 42.6 percent solids. The product was added to tapioca gum in two different proportions. The yarns were tested for breaking strength, elongation, resistance to abrasion, and for size distribution in the cross section. Cloth was woven from the yarns, and the shedding of fiber during weaving and the number of loom stops were noted. Samples of fabric were aged by heating in an oven and then desized to determine the ease of removal of the sizing.

Procedure

In planning the procedure for this series of tests it was decided to prepare three warps in which the percentage of Synthesize would be used in a formula with tapioca gum as the chief sizing agent. Other factors were kept constant in the three formulas. The first warp was sized with tapioca gum carrying no assistant. In the second test 5.2 pounds of the synthetic material were added. This represents 8 percent on the weight of the gum content. The third formula contained 16.25 pounds, or 25 percent of the gum content. This was probably excessive but was used to make the effect more pronounced for simplicity in observation.

TABLE II. Extraction records

Test No.	Extracted with CCl_4 %	Extracted with Exsize and water %	Total extracted material %	Moisture content %
21	0.03	8.98	9.01	6.87
22	0.22	8.26	9.48	4.15
23	0.75	10.38	11.13	4.82

Test 21—65 lbs. tapioca gum. No assistants
Cooking time: Brought to boil and cooked 10 minutes
Size-box temperature: 200°F

Test 22—65 lbs. tapioca gum
5.2 lbs. Synthesize Emulsion *
Cooking time: Brought to boil. Emulsion added and cooking continued for 10 minutes
Size-box temperature: 200°F

Test 23—65 lbs. tapioca gum
16.25 lbs. Synthesize Emulsion
Cooking time: Same as for Test 22
Size-box temperature: 200°F

Effect on Size Viscosity

Tapioca gum normally forms an amber-colored size paste with a relatively high degree of transparency. Addition of the emulsion caused a sharp decrease in transparency. Some tendency toward foaming was noticeable with the addition of 8 percent of the synthetic material, with an increase in viscosity to 4.25. The warp sized with this mixture has a distinct yellow tint. The presence of 25 percent emulsion caused the viscosity to rise to 4.62. A slight tendency toward foaming was noticeable. The presence of the agent also caused lumps to form in the size after about 20 minutes, indicating lack of stability. The results are given in Table I.

* The above formulas are based on 100 gallons of finished size.

TABLE III. Summary of abrasion records—strokes withstood

Threads	Test No. 21 No assistants	Test No. 22 8 percent Synthesize in sizing formula	Test No. 23 25 percent Synthesize in sizing formula
1–20	919	954	529
21–40	929	898	435
41–60	1,016	971	499
61–80	807	799	531
81–100	1,135	819	503
Average strokes withstood	48.06	44.41	24.97
Durability ratio*	6	5.5	3.6
Average 8 unsized			

* Ratio to unsized yarn.

Extraction Tests

Samples of the sized warps were extracted with carbon tetrachloride in Soxhlet extractors and were desized with a 3 percent solution of Exsize at 140°F for 1 hour. The samples were bone-dried before extraction and all calculations are based on the bone-dry weight. The results are given in Table II.

Size Distribution

Microscopic study of the cross section of threads from the three warps revealed some interesting differences in the disposition of the size. The size mixture containing tapioca gum alone showed a high degree of surface coating with slight penetration into the interior. The mix containing 8 percent of synthetic was distributed more on the interior of the thread with little on the surface, whereas the addition of 25 percent of the emulsion caused the size to fix itself on the surface with only slight penetration. It should for clearness be stated that the sections were stained in iodine vapor. The disposition of size referred to therefore includes only the gum or starch derivative. No method of staining the assistant has as yet been devised to enable its location in the yarn to be observed.

Abrasion Resistance

One of the means of determining the effectiveness of a sizing formula is the abrasion test. For these experiments samples of the sized warps were tested single-end by attaching a small weight (1 ounce) to the end of the test specimen and fixing it in contact with the cylinder of a Wyzenbeek Abrasion Tester until breakage occurred. The abradant used was 600–A silicon carbide paper. Samples from the three warps were tested simultaneously to insure that conditions were the same for all. The position of the three lots of material was varied on the drum in order to eliminate the possibility of this factor influencing the results.

TABLE IV. Correlation between tensile tests and weaving results

Test No.	Tensile strength (oz.)	Residual elongation	Stops per 1,000 picks	Ester* %
21	10.57	6.99	0.82	0
22	10.51	7.74	0.74	8
23	10.50	8.66	0.49	25

* Based on tapioca gum content (65 lbs. per 100 gals.).

It will be noted (see Table III) that abrasion resistance was lowered by use of the synthetic material.

The addition of 8 percent of resin ester was accompanied by a loss of 7.5 percent in resistance to abrasion, while the addition of 25 percent of emulsion accounted for a 50 percent reduction. These losses did not occur through deterioration of the fiber, since tensile strength and elongation were retained to a high degree except in the case of prolonged ageing of the fabric, in which case reduction in tensile strength was observed. The size mixture was noticeably less adhesive upon addition of the emulsion. It should also be stated that the higher performance in the weaving tests was not due to high abrasion resistance but to the increase in elongation which accompanied the use of the synthetic material and its fatty vehicle. Correlation between tensile tests and wearing results is shown in Table IV.

Shedding of Fiber in Weaving

One of the chief objectives of the warp-sizing research is the solution or alleviation of the shedding of surface fiber in weaving. It previously has been demonstrated that size mixtures of higher viscosity which coat the warp thread are most effective in reducing shedding. Also it is to be expected that any substance which tends to thicken the size and cause it to become fixed on the surface of the yarn will result in less shedding at the loom. The earlier experiences in this connection were verified in this series of tests in that there was a reduction in the shedding of fiber with each addition of emulsion.

While the use of Synthesize suggests a means of reducing shedding to some extent, it does not solve the shedding problem. The cause of fiber shedding seems to be inherent in the viscose fiber, which withstands relatively high tensile stresses when they are applied parallel with its axis but has little resistance to forces applied at right angle to its axis. The control of shedding must therefore await one of the following:

1. Change in the nature of the staple fiber to make it more resistant to stresses applied transversely to it.

2. More complete encasement of the warp yarn in a protective coating of size. This would demand greater volume of sizing materials, which should be of lower density to avoid excessive gain in weight and consumption of sizing agents.

3. Alteration of the present-day sizing process in which all the ends in the warp are sized in one plane to permit sizing in a multiple number of planes. This alteration would produce smoother sizing by binding the surface fiber to the body of the yarn. Such sizing is not possible with conventional methods because of the overlapping of surface fiber from adjoining threads in the sheet of yarn.

Ageing and Desizing

To determine the effect of storage on the removability of a size containing synthetic material, several yards of the fabric produced in the weaving tests were subjected to an accelerated ageing test by placing them in an oven for approximately 200 hours. The temperature of the oven was maintained at 160°F. At the end of this period the samples containing the agent had assumed a distinctly yellow cast, whereas the samples which did not contain the resin were not affected. Extraction of the size was accomplished without difficulty in all cases and no permanent discoloration of the fabric was observed.

TABLE V. Effect of ageing on fabric tensile strength

Text No.	Tensile strength: Before ageing (lbs.)	Tensile strength: After ageing (lbs.)	Loss %
21	56.4	56.1	0.53
22	60.9	54.7	9.9
23	56.7	52.5	7.1

Standard Ravelled Strip Test

To study the effect on the fabric of the synthetic sizing agent in the presence of heat, samples of the fabric were tested before and after ageing. The results of these tests, recorded in Table V, indicate that while ageing had no appreciable effect on the cloth sized with tapioca gum alone there was a loss of from 7.1 to 9.9 percent in the goods containing the synthetic agent. Since this weakening did not occur when the fabric was not subjected to the ageing test, the deterioration was not sufficient to eliminate its possible use as a sizing agent. No great significance is therefore attached to the loss in tensile strength.

The authors regard this material as worthy of further study on account of the improvement in weaving quality. Loom stops were fewer chiefly because of the improvement in residual elongation, and the lubricating qualities of the non-drying oil were beneficial in this direction.

IV. Application of Methyl Cellulose, a Water-Soluble Plastic, in Spun Viscose Warp Sizing

METHYL cellulose, a water-soluble ether, is one of many plastic substances available for use in warp sizing. It was selected for special study for three reasons:

1. It is soluble in cold water.

2. It serves to thicken size mixtures composed of starch and gums, giving sizing pastes of higher viscosities than are possible with the customary concentrations of these materials.

3. It has stabilizing influences in the size mixture, which are desirable.

Methyl cellulose is available commercially in six viscosity types which make possible a wide range of solution viscosities for a given content of plastic.

TABLE I. Effect of temperature on the viscosity of a 2% aqueous solution of methyl cellulose (100 CPS type)

Temperature C°	Time (Secs. per 100 rev.)	Relative viscosity
18	18.3	5.1
23	16.6	4.6
30	13.8	3.8
36	11.4	3.2
42	9.6	2.7
52	7.7	2.1
61	8.3	2.3
62*	8.6	2.4

* Began to go out of solution.

TABLE II. Effect of temperature on the viscosity of a ½-lb.-per-gallon corn gum paste containing 10% methyl cellulose on the weight of the gum

Temperature C°	Time (Secs. per 100 rev.)	Relative viscosity
80	12.6	3.5
70	10.2	2.8
60	9.4	2.5
55	10.8	3.0
49	13.0	3.6
40	15.5	4.3
35	16.9	4.7
30	19.1	5.3
25	22.4	6.2
20	24.7	6.9

The type selected for these studies was "high," a 2 percent aqueous solution of which yields solutions with an average viscosity of 100 centipoises at 23°C.

Methyl cellulose is produced in the form of white fibers. It is soluble in cold water but not in hot water. It was therefore evident that the customary size-box temperatures would have to be modified in order to make application possible. (This problem will be discussed further in a later section of this report.) Although it is insoluble in hot water, in solid form it is stable to heat, with no discoloration at temperatures up to 540°F. This is well above the maximum dry-can temperature and efficient drying is therefore easily accomplished. It is not affected by oily or greasy materials and may therefore be used with the usual softening agents for warp sizing. However, salts, such as sulfates, nitrates, and chlorides, cause coagulation. It is not sensitive to acids and alkalies and is not materially changed over a pH range of 2 to 12.

Procedure

Blending Methyl Cellulose with a Corn Gum

In the prospectus of methyl cellulose issued by its manufacturers the plastic is described as a thickener for sizing and finishing pastes. Such an agent would provide desirable viscosity in a size mixture containing a relatively small percentage of sizing material. Therefore a series of preliminary tests were performed to study the effect of the plastic on a corn gum. The gum selected in ½ pound per gallon concentrations yielded a size paste at 180°F, which had a relative viscosity rating of 1.8, contained 1.2 percent cold-water solubles and 0.24 percent ash, and had a pH of 6.2.

The methyl cellulose viscosity type selected for the tests was a "high," which in a 2 percent solution at 20°C has an average viscosity rating of 100 centipoises. A stock solution was made up with 1 g. of methyl cellulose in 40 cc. of water. This solution was added to a stock mixture of the corn gum containing ½ pound per gallon of paste in the proportion of 600 cc. of paste to the required proportion of methyl cellulose solution, and the resulting mixture was brought up to a volume of 400 cc. with water. In this manner the amounts of corn gum and water were kept constant, with the methyl cellulose the only variable. Viscosity readings were taken on the corn gum paste containing no methyl cellulose and on five combinations of corn gum paste and methyl cellulose solution. All readings were made at 80°C. It was found that each rise in the methyl cellulose content was accompanied by a rise in the viscosity of the mixture. The Stormer Viscosimeter was used and all readings are expressed in relation to water at 80°C. It should be observed that the methyl cellulose percentages are based on the weight of gum present and not on the water content. Ten percent methyl cellulose represents approximately 0.5 percent of the total water content of the size mixture. This concentration can be used without gelation at the normal sizing temperature of 180°F. When cold solutions of the plastic are heated, the viscosity is lowered at a gradually decreasing rate. If the temperature is raised high enough, the viscosity will no longer be lowered but will rise abruptly and a jelly will be formed. The gel point depends upon the concentration and the viscosity type. In low concentrations it is possible to raise the temperature indefinitely without gelation. The effects of temperature on viscosity are given in Tables I, II, and III

TABLE III. Effect of temperature on the viscosity of a ½-lb.-per-gallon corn gum paste

Temperature C°	Time (Secs. per 100 rev.)	Relative viscosity
80.0	6.3	1.7
70.0	6.5	1.8
62.0	6.9	1.9
55.0	7.2	2.0
50.0	7.5	2.1
39.0	8.0	2.2
35.0	8.2	2.3
30.5	8.4	2.3
25.0	8.8	2.4
22.0	9.2	2.6

and are shown graphically in Figures 1, 2, and 3. It can, therefore, be readily seen that the percentage of methyl cellulose used in a sizing formula must of necessity be small or lower size-box temperatures must be used. The results of the blending tests are given in Table IV and are shown graphically in Figure 4. It will be observed that an increase in viscosity occurs with each increment of the plastic. This increase is gradual with additions up to 10 percent. From this point a sharp rise in viscosity occurs as the percentage is advanced to 12.5 percent, indicating that the gel point for the methyl cellulose has been reached. The viscosity of the mixture at this point is unstable because of the separation of the plastic.

TABLE IV. Effect of methyl cellulose on the viscosity of a corn gum paste

Test No.	Methyl cellulose %*	Relative viscosity
1	0.0	1.8
2	2.5	2.4
3	5.0	2.8
4	7.5	3.2
5	10.0	3.5
6	12.5	6.0

* Based on corn gum content.

Size-Box Temperatures

The effect of size-box temperatures and proper regulation at this point in slashing has been suggested as worthy of study in connection with the warp-sizing experiments. That constant temperature conditions should be maintained at all times in order to insure uniform results is generally conceded. It is also true that the size must be kept hot in order to prevent coagulation of the size paste. Heat also promotes penetration of the size into the yarn, and in cotton slashing resistance to penetration and to proper anchorage of the size film to the fiber and yarn is encountered in the form of natural gums and waxes. This condition does not exist in yarns made from viscose staple. It is therefore logical to

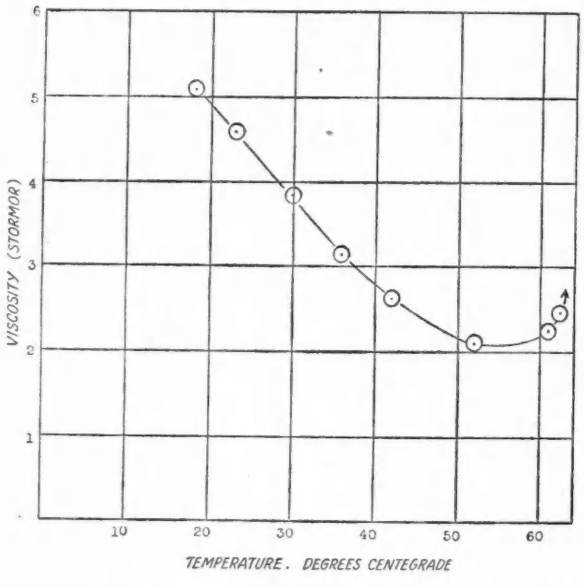

FIG. 1. *Effect of temperature on the viscosity of a 2 percent solution of methyl cellulose (high viscosity type).*

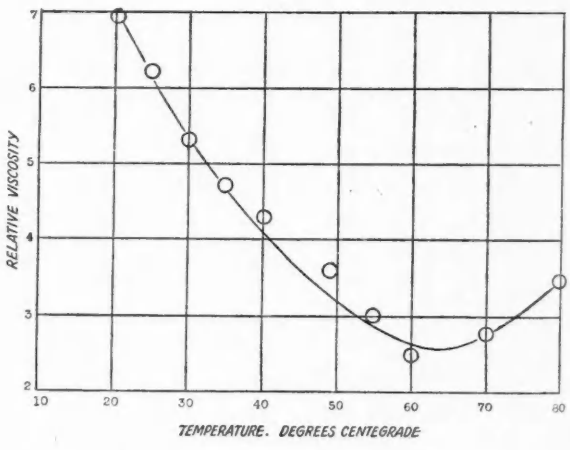

FIG. 2. *Effect of temperature on the viscosity of a ½-pound-per-gallon corn gum paste containing 10 percent of methyl cellulose (100 CPS).*

assume that lower temperatures are possible in spun-rayon slashing.

The question of size-box temperature is of special importance in connection with the use of methyl cellulose because this material coagulates at high temperatures, depending upon the concentration and the viscosity type used. In the application of a size containing water and methyl cellulose alone, it therefore was necessary to determine whether cold sizing was practical.

Accordingly, one warp was sized with a mixture containing 0.15 pound of 100 CPS methyl cellulose per gallon of size. The size box was kept at room temperature. The normal dry-can temperatures were maintained and no difficulty was experienced in satisfactory drying or with free separation of the warp at the split rods. While the percentage of size applied was small (6 percent), the weaving operation was satisfactory.

Abrasion Resistance

Abrasion resistance tests were performed on single ends of the sized warps to determine the efficiency of the size film in withstanding chafing. This test is performed by arranging 20 ends upon the drum of the abrasion tester. A weight of 1 ounce was attached to the free end of each thread. Silicon carbide paper (600 A) was used as the abradant. Records were kept of the number of strokes required to sever the thread. A durability ratio is obtained by dividing the number of strokes withstood by the number required to sever the unsized thread.

The results obtained by these tests are recorded in Table V. A wide difference in abrasion resistance was observed. The warp sized with methyl cellulose alone had an average abrasion resistance of 50 strokes, which is approximately six times the resistance of unsized yarn. Corn gum alone produced a yarn with an average abrasion resistance of 28 strokes, which is more than three times that of unsized yarn. A mixture of corn gum and 10 percent methyl cellulose produced a sized yarn with an average abrasion resistance of 40 strokes, which is better than that recorded for yarn sized with corn gum alone. Approximately 6 percent of size was applied to the warp in each case. It is to be concluded from these tests that methyl cellulose when used alone will produce a sized warp with high resistance to abrasion and that its use in combination with a corn gum will raise the resistance to abrasion.

TABLE V. Summary of tensile and abrasion-resistance tests

Sizing agents	Break (oz.)	Elongation %	Abrasion resistance (cycles)	Durability ratio
Methyl cellulose	8.2	11.5	50	6.25
Corn gum and 10% methyl cellulose on weight of gum	8.0	11.1	40	5.0
Corn gum	7.94	11.8	28	3.5

Quantitative Stiffness Measurements

One of the criteria for the selection of a satisfactory sizing formula is the effect of the size on the stiffness of the fabric. This quality is reflected in the hand or feel of the goods. In the selection of fabrics, the buyer will favor the fabric which pos-

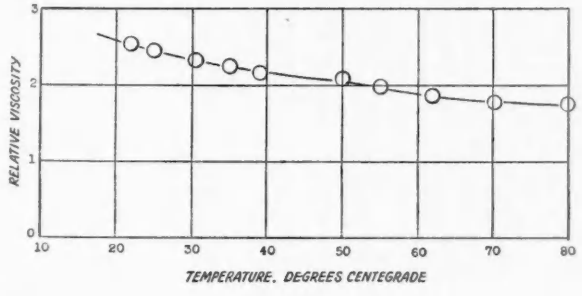

FIG. 3. *Effect of temperature on the viscosity of a ½-pound-per-gallon corn gum paste.*

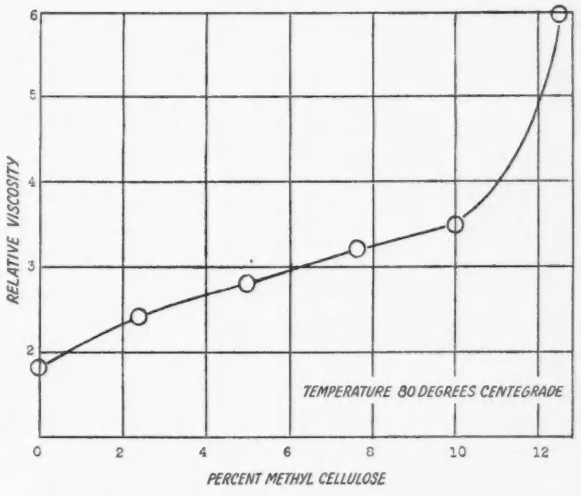

FIG. 4. *Effect of methyl cellulose on the viscosity of corn gum paste.*

TABLE VI

Sizing formula	Rating in stiffness units	Ratio to desized fabric
0.15 lb. methyl cellulose per gallon	20.7*	2.07
0.5 lb. corn gum per gallon 10% methyl cellulose	29.1	2.91
0.5 lb. corn gum per gallon	35.5	3.55
No sizing	10.0	1.0

* Lower rating indicates softer fabric.

sesses the highest degree of softness and fullness, other things being equal. The available sizing materials vary widely in their stiffening power on yarns and fabric. For this reason it seemed advisable to devise some method of giving the fabrics a numerical rating. An instrument was accordingly constructed after a plan suggested by Peterson and Dantzig (U. S. Department of Agriculture, Technical Bulletin No. 108, 1929). This report included a description of a quantitative method for evaluating the stiffness of fabrics treated with different starches.

The device, illustrated in Figure 5, consists of an upright panel (B) into which a groove has been cut at an angle of 45 degrees with the horizontal. Into this groove is fitted a wooden member (M) which projects from the board about 2½ inches. At the upper terminal of this member is a pair of feed rolls (RR). The point of tangency between these rolls marks the point O, on the scale S, which extends parallel to the support M.

In operation, a strip of fabric 2 by 6 inches is started through the rolls in the direction of the arrow in Figure 5. At the beginning of its movement the fabric sample will be partially supported by the member M. Eventually, however, the fabric strip will support itself, the point of support depending upon the degree of stiffness it possesses. A reading is taken at the point on the scale where the specimen supports itself. The scale is graduated in stiffness units. One unit on the scale is 2.325 mm. (The cube root of the elastic modulus: $\sqrt[3]{4\pi}$.)

Great care should be exercised in preparing the fabric specimens for rating on the stiffness tester. Crushing or creasing should be avoided, as wrinkles or other deformation of the fabric will cause errors in the readings. In testing grey goods it is considered satisfactory to take the samples from the cloth roll and cut and condition them for testing without further treatment. If for any reason the goods to be rated have become wrinkled, the specimens should be pressed with an iron and allowed to condition prior to testing. The curved line in Figure 5 represents the profile of a swatch of fabric with its lower extremity barely touching the support at 58 units on the scale. This specimen would thus be given a stiffness rating of 58.

Rating of Fabrics Produced

The fabrics produced in this series of tests were rated by means of the stiffness tester and found to vary widely in this quality. Their quantitative ratings are recorded in Table VI, along with the rating for the desized fabric.

The results tabulated in Table VI indicate that methyl cellulose increases the flexibility of the corn gum film, thus producing a softer fabric. The value of flexibility in the sized warp is reflected not only in the production of grey goods with better hand but in improved weaving quality. Flexibility contributes to good weaving because of the great amount of flexing which the warp undergoes, particularly at the heddles. It is of greater importance in weaving yarns spun from viscose staple than in weaving those spun from cotton because of the relatively low resistance of the viscose fiber to shear. Observation indicates that a frequent form of end breakage is shearing at the heddle. Such shearing is usually the result of interference by a knot on an adjacent thread.

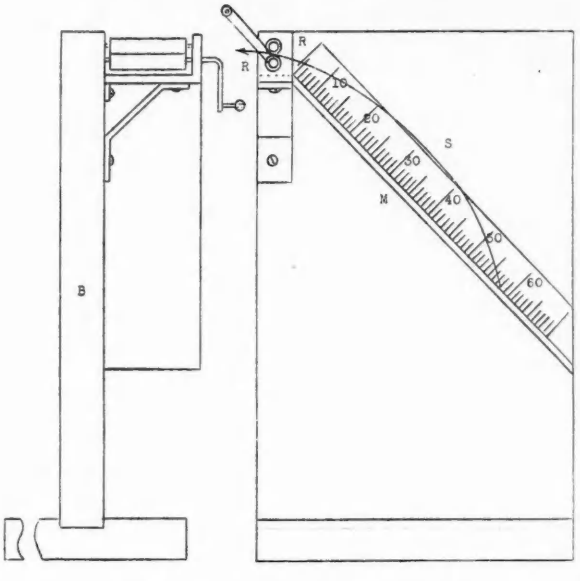

FIG. 5. *Diagram of stiffness tester.*

TABLE VII. Record of end breakage

Test No.	Sizing	Knots	Gouts	Weak places	Unknown	Total
24	Methyl cellulose	0	1	0	2	3
25	Corn gum and 10% methyl cellulose	5	0	0	4	9
26	Corn gum	4	0	0	9	13

Flexibility increases the resistance of the warp to end breakage of this type.

Weaving Tests

The most important outcome of the weaving tests in this series is that it is possible to weave yarn sized with methyl cellulose alone. The end breakage record shows a decided reduction in the number of loom stops from various causes. This improvement is attributed to two things:

1. High abrasion resistance of the yarn sized with the cellulose plastic.
2. Greater flexibility of the warp yarn.

It is also significant that by using a portion of the plastic material in a mixture, composed largely of corn gum, abrasion resistance and better weave room performance may be expected. It was observed also that the shedding of fiber from the surface of the warp in weaving was less for the warp sized with corn gum and 10 percent of methyl cellulose. It should be observed that while end breakage was slightly higher for yarns sized with corn gum alone (see Table VII), this condition was due in part to the lack of a softening agent. The softener was omitted to eliminate additional variables.

TABLE VIII. Loom stops

Test No.	Stops per 1,000 picks	Stops—8 hours
24	0.05	4.27
25	0.14	12.0
26	0.24	20.5

Other sizing and weaving tests have been conducted with methyl cellulose as the object of investigation. It has been found that satisfactory weaving is possible with as low as 3.25 percent of size on the warp, the size composed of methyl cellulose and water. The size was applied from a cold size box. In this test the shedding of fiber was considerable because of the small amount of size present on the yarn.

Some experiments have also been carried out with combinations of glue and methyl cellulose with fair results. Such a combination is not recommended for sizing yarns composed entirely of viscose fiber. Methyl cellulose should be classed as a warp-sizing assistant, and not as a substitute for starch or starch derivatives. As such it is naturally a substitute for glue in sizing. Its chief advantages are:

1. It toughens the size film.
2. It increases the viscosity of the size and assists in forming a protective coat on the surface of the warp yarn.
3. It is soluble in water and is easily removed.
4. It improves the hand or feel of the grey goods.

Swelling of Fibers as a Method for Morphological Research

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Dayton, Ohio

The application of cinemicrography to the dark-field ultramicroscopy of textile fibers permits repeated and close observation of the rapidly changing movements of colloidal inclusions energized by suitable swelling agents. Through this technique the permeable membranes of starch particles and natural fibers are made visible. The effects of osmotic pressure, such as the instantaneous eruption of colloidal masses from the ruptured envelope of starch grains and cotton fibers, have been recorded by the motion picture camera and thus made available for careful study.

The inhomogeneity of wool scales and their capsule-like structure are recorded. The movement of colloidal particles within and through the outer walls of the swollen cotton fiber has been photographed and it can be analyzed at leisure by projecting the film.

The fact that some of the material in this article has previously appeared in Kolloid Zeitschrift **64**, *257 (1933), and* Der Papier-Fabrikant **32**, *61 (1934), emphasizes its value, and for this reason it is now being presented in its present form in this journal.*—Editor.

MORPHOLOGICAL research on natural and synthetic fibers was started a long time ago. However, the usual methods have certain limits that cannot be overstepped. Certain details of fiber structure are invisible under the ordinary microscope and do not show up even in powerful magnifications. The polarizing microscope proved very useful for the observation of cellular structures, but it had other limitations. The x-ray diffraction method—which goes into molecular dimensions—is much too fine for drawing conclusions about the shape of such coarse objects as textile fibers. The electron microscopical method requires the breaking down of fibers, thus destroying the relatively large cell structures, and all objects have to be observed in the dry state and *in vacuo*, which excludes studies of swelling processes.

The ultramicroscope is the only instrument which permits observation of very small objects without limiting the field of vision too much. It also permits the study of swelling processes, since an almost homogeneous optical field, which results from imbedding a solid object into a liquid, is advantageous.

It is known that fibers like cotton or wool consist of an intricate system of skins, cells, scales (in the case of wool), etc. The geometrical distribution of these units cannot be clearly seen by direct observation of these fibers. The microscope is necessarily limited to observation at a certain level, and focusing does not aid materially in the visualization of three-dimensional structures.

However, the swelling of a fiber, for example, affords an indirect means of tracing the skin system. If the sturdy system of a cotton fiber is loosened by appropriate methods, details can be seen that ordinarily would remain unnoticed.

A special way of tracing such geometrical contours would consist of filling a cavity with a clearly visible

* This paper was delivered at the September, 1944, meeting of the Industrial Fiber Society, held at the Callaway Auditorium in La Grange, Ga. Dr. Roberts accompanied his paper with motion pictures of the original film from which the sections illustrated herewith were taken.

medium and then watching to see whether, when, and where this medium leaves the cavity. These phenomena can be produced more or less readily by the method of selective swelling.[1] By proper swelling and counteraction ("deswelling," syneresis), a colloid chemical state can be attained in which the transition from swollen to unswollen particles reaches almost molecular dimensions. Such particles can be seen under the ultramicroscope; their statistical movement and their speed can be studied, and local changes (such as streaming of the whole agglomerate) can be noticed. This movement is known to the physicist as the "Brownian movement." It is an energy-free movement, the speed of which depends essentially upon the temperature and the viscosity of the liquid medium, and also upon the size, the shape, and the concentration of the particles. The ultramicroscope is a "light-dark" instrument, showing scattering of the light on particles, the size of which goes down to 10^{-6} cm. It is constructed on the principle of indirect illumination, similar to that of a planet against the dark night sky. No colors can be seen in the ultramicroscope. It distinguishes only between white and black. No quantitative conclusions can be drawn from observation in the "dark field," nor can the shape of objects be judged. However, their presence, movement, and disappearance can be seen; also the limitation within a closed skin, or, if there is a hole in the skin, the extrusion of the whole cloud of Brownian movement through it.

For special investigations a mechanical tool is necessary, which will permit cutting, removing, puncturing, etc., of small objects under the microscope. For these purposes the micro-needle has been found to be a practical tool. This technique of micromanipulation makes use of glass needles, especially prepared for the purpose, which have very sharp points of various shapes (a needle with which to hold an object is different from one which is used to puncture a skin, and also from one to be used for removing and turning an object, etc.). Macro- and micro-screws provide left-right, back-forth, and up-down movements. Furthermore, tilting and turning around an axis can be achieved. The size of the micro-movements is of such an order that even under high magnifications the operations can be done within the field of vision. (Biological applications of the micro-needle technique include operations on bacteria.)

Another technique necessary for quantitative observations of changes of length of area, due to swelling, etc., is cinemicrography. Fast-moving reactions—for example, the sudden bursting of a highly swollen fiber—cannot be analyzed merely from watching them under the microscope. However, by taking moving pictures and by comparing successive exposures and measuring the distance a particle has moved within a known time interval, its speed can be determined with considerable accuracy. Furthermore, the cinemicrography technique permits the study of the most typical phase of a fast reaction, which might last for only a small fraction of a second, far too short a time for taking an ordinary photomicrograph.

This combination of four techniques—namely, (1) ultramicroscopy, (2) micromanipulation, (3) cinemicrography, and (4) selective swelling—has been used for studying cotton and wool fibers. Furthermore, as a model substance, starch grains were investigated, since they show clearly the morphological details of a grown structure and illustrate the application of the four methods described above.

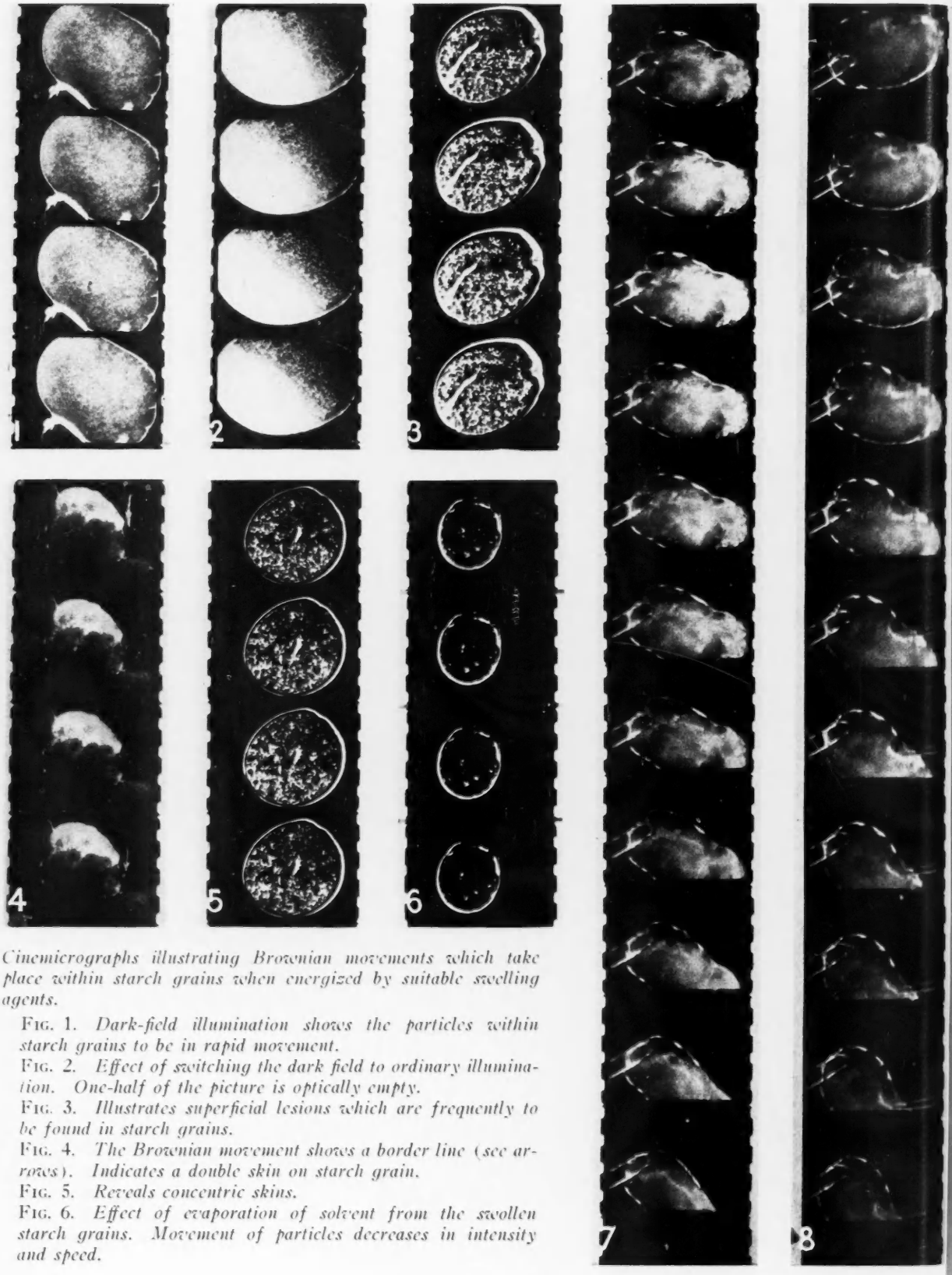
Experimental Procedure

1. Studies on Starch Grains

The starch grain is particularly good as a model substance for all morphological work in connection with swelling, micromanipulation, dark-field microscopy, etc.

If potato starch is heated in water for 5 minutes to 70°C, the grains are swollen, but only mildly, so that the skin does not break on account of the swelling pressure. Under the ultramicroscope the inside of the undamaged grain appears to be empty. If, however, to the wet and swollen grain a drop of a solvent such as ethanol, methanol, dioxane, ether, glacial acetic acid, or some other solvent is added, the picture changes completely. In the grain a partial deswelling effect takes place and produces Brownian movement. This movement is very intense, and literally tens of thousands of tiny points come out,

[1] The method of selective swelling is advantageous in that the object is attacked from the inside without mechanical damage. The semipermeable skin permits the penetration of a swelling agent from the outside, but this agent becomes active only after it is inside the pocket and in contact with its contents. This method is, of course, quite different in principle from the dissolution of a crystal and other similar phenomena. In the case of selective swelling proper, two or more liquids may be inserted successively in a closed structure, and can change in a controlled way the degree of swelling. See *Kolloid Zeitschrift* **64**, 257 (1933).



Cinemicrographs illustrating Brownian movements which take place within starch grains when energized by suitable swelling agents.

FIG. 1. *Dark-field illumination shows the particles within starch grains to be in rapid movement.*

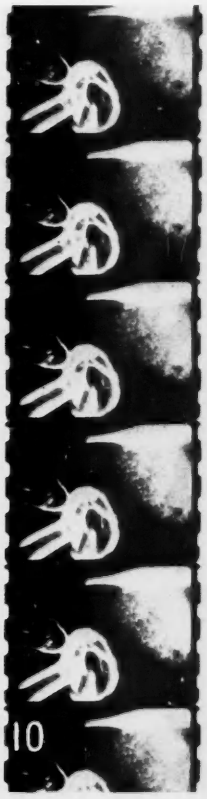
FIG. 2. *Effect of switching the dark field to ordinary illumination. One-half of the picture is optically empty.*

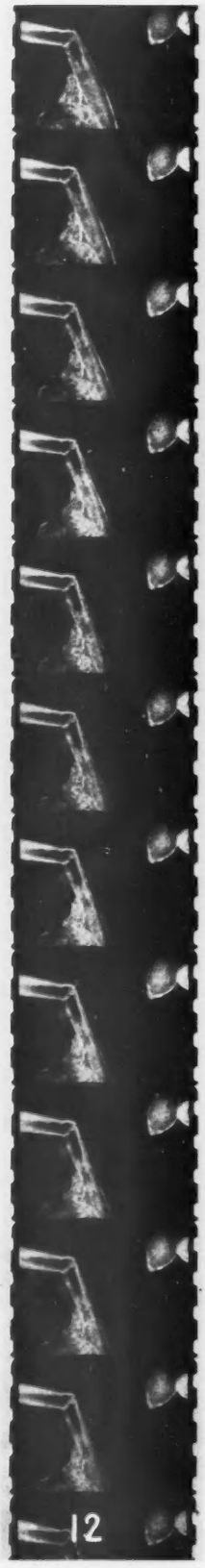
FIG. 3. *Illustrates superficial lesions which are frequently to be found in starch grains.*

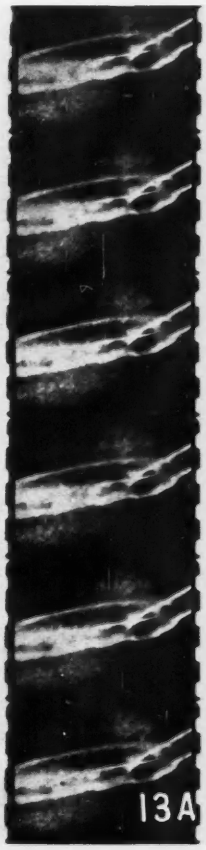
FIG. 4. *The Brownian movement shows a border line (see arrows). Indicates a double skin on starch grain.*

FIG. 5. *Reveals concentric skins.*

FIG. 6. *Effect of evaporation of solvent from the swollen starch grains. Movement of particles decreases in intensity and speed.*







Brownian movements within swollen starch grains.

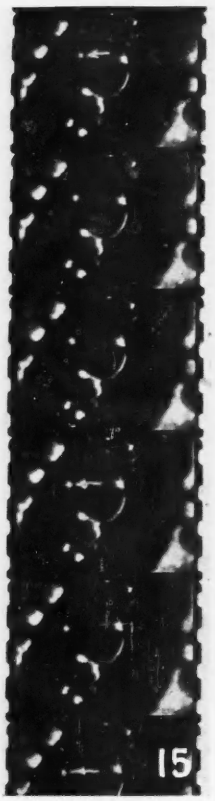
FIGS. 7 AND 8 (*opposite page*). *Illustrate toughness of skin of the starch grain.*

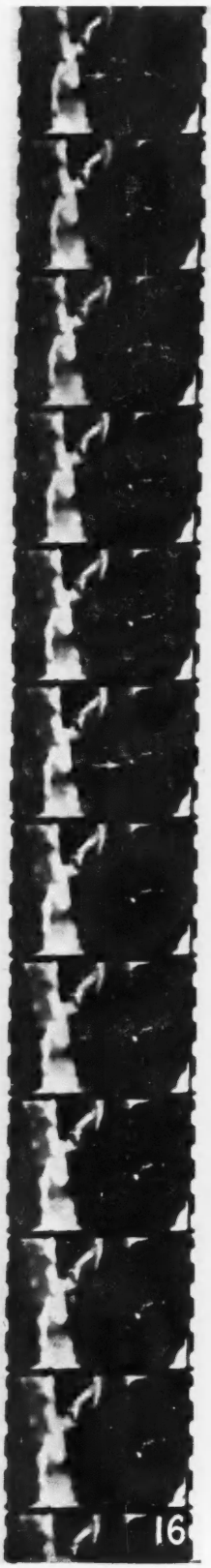
FIG. 9. *Effect of puncture of the skin. Cloud erupts from grain.*

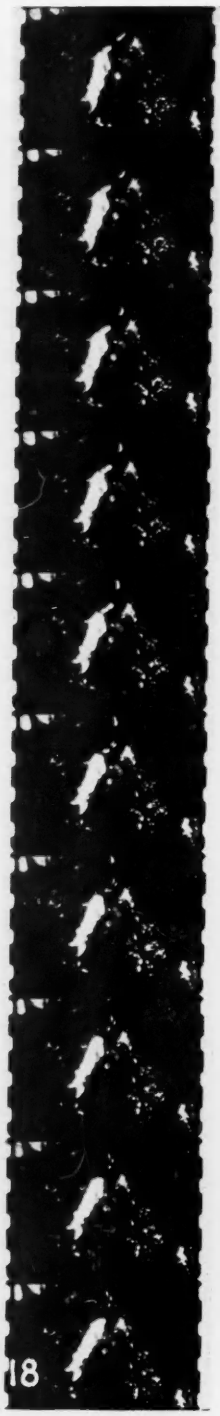
FIG. 10. *Empty skin held by holding needle. Cloud of particles in rapid movement has followed needle which was used to puncture skin.*

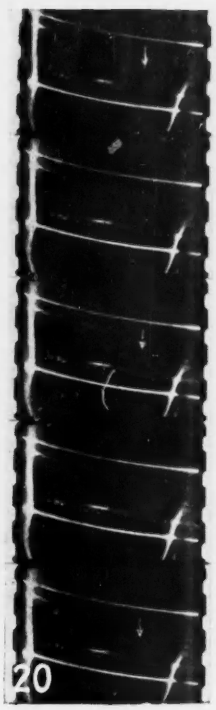
FIG. 11. *Cloud readily follows the point of the needle.*

FIGS. 12, 13A, AND 13B. *Illustrate strength and elasticity of the skin of the starch grain.*









Brownian movements produced by treatment of cotton fibers with swelling agents.

FIGS. 14 TO 20 *inclusive show progress of the action during successive stages of the treatment.*

disappear, come out again, and so on. Figure 1 shows these particles. Considering the small size of the whole starch grain, we realize the extremely small dimensions of the particles. If the ultramicroscopic dark field is switched to ordinary illumination, the structures disappear immediately, and the field becomes optically empty. In Figure 2 this is true on one-half of the picture.

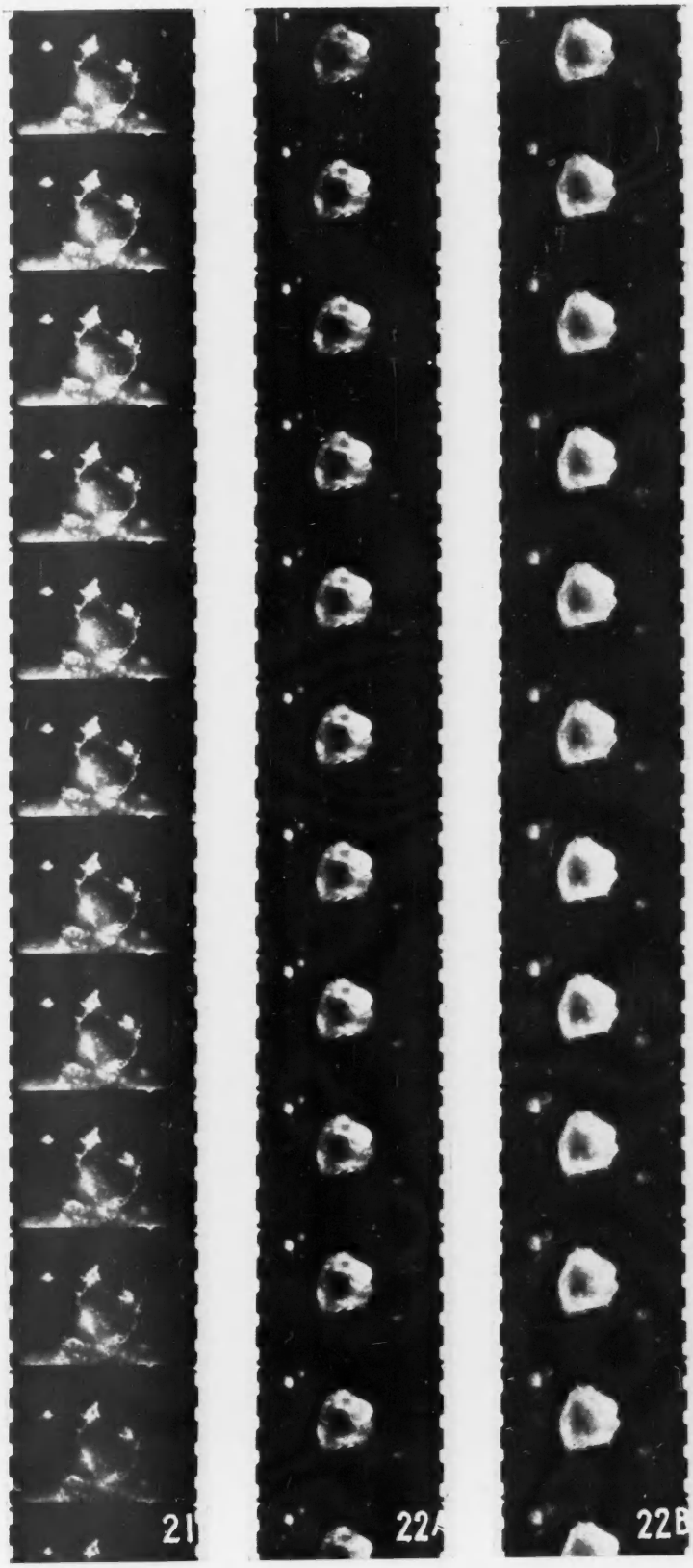
Certain grains exhibit a considerable number of lesions (probably from the process of growing). These skin inhomogeneities in no way impair the movements of the particles, nor do they permit them to leave the grain. In Figure 3 such a surface inhomogeneity is shown. We might consider these lesions as only superficial deformations which do not reach to the grain center.

The skin of the starch grain apparently is a double skin. The Brownian movement shows clearly a border line (see arrow on the right side of Figure 4). Although this double skin system is irregular in shape, concentric skins are visible in Figure 5.

If the solvent added to the water-swollen starch grain is allowed to evaporate gradually, the Brownian movement decreases in intensity and speed (Figure 6). Finally, if only water is left over within the grain, it stops completely. If, however, the cover-glass is sealed and no evaporation can take place, the Brownian movement can be observed for months.

Attempts to break a swollen starch grain with the needle of the micromanipulator show the extreme toughness of the starch skin. It can be bent but evades all pressure by changing its shape. In Figure 7 a grain is flattened by the microneedle, but it does not break. Even the assistance of a second needle (Figure 8) is of no avail. The tough elastic skin readily gives way but does not break.

Only by using an extremely sharp needle and by moving it very suddenly,



FIGS. 21, 22A, AND 22B. *Illustrate effect of treatment of wool fiber with swelling agents.*

so that the grain has no time to avoid the attack, can the skin be punctured. In Figure 9 this operation is shown. The heavy needle is the holding device, keeping the grain from slipping away. The thin needle does the actual operating and the eruption-like extrusion of the grain contents takes place. The cloud, now outside the grain, has found its way through the puncture within a small fraction of a second (time interval between two frames is $\frac{1}{40}$ second). The contents of the grain are now outside of the empty skin and continue to show Brownian movement. Figure 10 shows the empty bag still held by the first needle, while the second needle and the cloud of Brownian movement are outside the skin.

The "cloud" of Brownian movement is consistent in itself and apparently has a high viscosity. This can be shown by movements with the micro-needles. The mass readily follows the point of the needle (Figure 11).

How tough the empty skin of the grain is can be seen in Figure 12. The two needles of the micromanipulator (only one is visible in the picture) pull the skin apart. It becomes thinner on account of its elongation, but its strength keeps it from breaking.

In Figure 13, the formerly almost sphere-shaped grain is now stretched to a tubelike shape (Figure 13A). Even in this stretched state it resists all attempts to tear it apart (Figure 13B).

2. Experiments on Cotton Fibers

Cotton fibers were treated for 12 to 24 hours with a solution of 17 percent by weight of sodium hydroxide in distilled water, and under the microscope a few drops of cuprammonium solution were added. The latter contained 0.586 g. cupric hydroxide and 0.68 g. sodium hydroxide in 100 cc. of ammonium hydroxide (technical 20 percent ammonia). This treatment starts a violent swelling process which proceeds roughly through the following stages:

First, particles in the center of the fiber become visible in the ultramicroscopic beam. They start a rapid movement in the center channel of the fiber. Figure 14 shows this streaming process. The arrows point to the visible particles, and the high speed of the movement is indicated by the fact that between two consecutive frames a time interval of about $\frac{1}{40}$ second has elapsed. The progressive swelling pressure now becomes effective from the inside towards the outside and gradually the well-known pearl chain structure develops. The increasing swelling pressure is too much for the weakened cell wall and the latter breaks. Streaming particles leave the fiber and settle down after their kinetic energy is exhausted (see arrows in Figure 15).

The speed with which the undissolved particles are ejected from the swollen fiber becomes more evident from Figure 16. This figure also illustrates the changes in the position of the extruded particles against each other after they have left the probably extremely small hole in the cell wall. The particles stream out in a straight line and disassemble immediately when the pressure has subsided.

The longer the action of the cuprammonium solution against the sodium-hydroxide-swollen cotton fiber is applied, the softer the fiber becomes. Violent center streaming is then combined with eruption through the punctured cell wall. Figure 17 shows this process, which finally results in complete destruction of cell structure and wall, and both large and small particles settle down (Figure 18).

If an undamaged piece of fiber is swollen in a very cautious manner, the difference in swelling power between sodium hydroxide and cuprammonium solution can be adjusted in such a way that inside the closed fiber Brownian movement is produced. An excess of cuprammonium usually works in this direction (Figure 19). The horizontal fiber shows the typical Brownian movement along the fiber axis. Increasing cuprammonium concentration swells the fiber radially, apparently "inflates" the cylinder, and Brownian movements inside the hollow cylinder show the limitations in radial direction. This is illustrated in Figure 20.

3. Experiments on Wool

Merino wool fibers were steeped for 24 hours in cuprammonium solution of similar concentration to that used for swelling cotton. With this treatment the surface scales of the wool fiber turn vertically to the fiber, without losing contact with the fiber body. This is caused by the swelling effect of the cuprammonium and, partially, by disruption of the material between scale and fiber body (dissolution of cementing substance (?)). By adding a drop of water to the highly swollen wool scale, the state of swelling is changed and strong Brownian movement within the scale becomes visible. This movement takes place strictly within the scale and no transition into the cylindrical fiber body is visible. Figure 21 shows this phenomenon. If the steps in the cuprammonium-water treatment are reversed—that is, if

the wool fiber is first immersed in water and thereafter cuprammonium is added—similar Brownian movement can be observed. It was found that the connection of the scales with the fiber body was still rather strong. The scales can be moved up and down without breaking off from the main fiber. If more force is applied, however, they can be detached. Such a detached wool scale again shows Brownian movement, if treated with cuprammonium-water. The Brownian movement is restricted to the scale and no hole can be seen through which it could "escape." Even the point at which the scale was previously connected with the fiber body is completely sealed.

In Figures 22A and 22B, different degrees of swelling are shown. The small light points reveal the Brownian movement. Their location with respect to each other changes from frame to frame and shows a continuous movement if the film is projected properly.

The wool scale has a very hard surface and all attempts to puncture it with the micro-needle failed.

Acknowledgment

I wish to thank Miss Sally Aulabaugh of our laboratories for her efficient help in copying the film strips from the original movie film.

Institute to Give Research Reports at Regional Meetings

TEXTILE Research Institute will present a series of reports on current textile research at regional meetings to be held in April at textile mill centers in several states.

The meetings are designed especially for mill engineers and technical men in the local areas, and all are invited, but only a limited number from outside the local trading centers can be admitted. In order to cooperate with the Office of Defense Transportation, the Institute has planned these regional meetings so that the reports may be heard by as many textile workers as possible with a minimum of travel.

Research papers to be read at each meeting are: "Abrasion Test for Textiles," by Dr. A. C. Walker, Bell Telephone Laboratories, Murray Hill, New Jersey; "Methods of Increasing the Productivity of Cotton Cards," by Elliot B. Grover, head, Yarn Manufacturing Department, North Carolina State College School of Textiles, Raleigh, North Carolina; "Practical Applications of a New Analysis of Equilibrium Regain Data for Textile Fibers," by John C. Whitwell, associate professor, Department of Chemical Engineering of Princeton University, and member of the Textile Research Institute staff; and "Infra-Red Drying of Textile Materials," by Richard H. Wilhelm, associate professor of chemical engineering at Princeton University, and member of the Textile Research Institute staff.

Opportunity for discussion of the subjects covered in the papers will be provided at each session.

The meetings will be held in Atlanta, Georgia, at the Georgia School of Technology, Monday, April 9, in two sessions—10:30 A.M. and 2:00 P.M.; in Spartanburg, South Carolina, at the Cleveland Hotel, Wednesday, April 11—2:30 and 7:30 P.M.; and in Raleigh, North Carolina, at the North Carolina State College School of Textiles, Saturday, April 14—10:30 A.M. and 2:30 P.M.

All of the papers except "Methods of Increasing the Productivity of Cotton Cards" will be repeated in Philadelphia, Pennsylvania, at the Philadelphia Textile Institute, Thursday, April 26, at 1:30 P.M.

All of the papers except that on abrasion represent work conducted by the Applied Research Department of the Institute under the direction of Giles E. Hopkins, Director of the Department. The paper on increasing the production of cotton cards is the first public progress report of the project sponsored by the Office of Production Research and Development, performed at the North Carolina State College School of Textiles in cooperation with the Institute. The other two papers cover problems now under study at the Princeton laboratories of the Institute.

Inquiries about the programs should be addressed to Giles E. Hopkins, Director of Applied Research, Textile Research Institute, 10 East 40th Street, New York 16, New York.

Book Reviews

A Primer of Electronics. Don P. Caverly. New York, McGraw-Hill Book Co., 1943. 235 pages. Price, $2.00.

(Reviewed by E. R. Schwarz)

The first two parts of this four-part book deal with electric current and magnetism, and by means of simple analogies and numerous illustrations lay a foundation for the combination of these principles with those of electromagnetic radiation and electronics proper, which are the subjects of the last two parts.

The author applies the term "electronic" to a device which is deliberately designed to make use of electron emission. Although only three chapters are devoted to such devices, the author could hardly have omitted the preceding eleven chapters and still retain the quite proper title of *Primer*. No background information in electricity on the part of the reader is assumed, nor is he assumed to have any knowledge of radiation phenomena—light, heat, ultraviolet, or supersonic. Sufficient information on these subjects is simply and directly presented and is followed by a non-technical but reasonably detailed discussion of the more important electronic devices. These include types of vacuum tubes ranging from the diode through the pentode, the beam-power and the triode heptode converter. The functions of the cathode, the control and screen grids, and the plate are clearly described. The operation and principal uses of fluorescent tubes, strobotrons, photoelectric tubes, cathode ray tubes, iconoscopes, x-ray tubes, and the electron microscope are briefly outlined.

For the textile research worker who will be called upon increasingly to deal with devices employing electronics the book affords easy access to a general understanding of the subject. X-ray diffraction patterns as a means of investigating details of submicroscopic fiber structure are already familiar to the textile technologist, as is the use of the strobotron in obtaining high-speed photographs of moving machinery—in particular for looms. The photoelectric cell is also frequently employed in the mill as well as in the laboratory. The cathode ray oscillograph is coming into use, as in the Slater Impact Tester at the Massachusetts Institute of Technology. The use of supersonics and high-frequency oscillations for laboratory testing of such properties of fibers as their instantaneous modulus of elasticity, or in the plant for the dielectric heating of textiles for drying or for twist setting, is being reported in the literature. As a painless introduction to electronics and its application, the book is recommended.

Organic Chemistry. Louis F. Fieser and Mary Fieser. Boston, D. C. Heath and Company, 1944. 1,019 pages. Price, $8.00.

(Reviewed by Albert G. Chenicek)

In the first section of this book there is quoted a letter by Wöhler written to Berzelius in 1835, saying: "Organic chemistry just now is enough to drive one mad. It gives me an impression of a primeval tropical forest, full of the most remarkable things, a monstrous and boundless thicket, with no way to escape, into which one may well dread to enter."

In writing a new text on organic chemistry, the authors have provided an excellent map of all the highways and byways, the trails, even the faint footpaths, which now exist in the former "primeval forest." Each path is marked with the names of the men who first blazed the trail. The latest explorations in many directions are indicated.

The chemistry of aromatic compounds is discussed in greatest detail. This, plus chapters devoted to biological chemistry, is possibly an expression of the authors' own interests. Such emphasis does not detract from the value of the book to the general reader.

Unlike most textbooks, this one includes in each chapter much material on practical applications and discussions of modern commercial syntheses of organic compounds. In addition, special essay chapters have been used to present the practical side of organic chemistry. Of particular interest are the chapters on dyes, synthetic fibers, and synthetic plastics and resins.

The subject of dyes is introduced by a section on color and constitution, with a discussion of chromophores and auxochromes based mainly upon resonance effects. This is followed by a short section on the applications of dyes to fibers. The remainder of the chapter is devoted to the dyes themselves. The

historical background of each type is presented and methods of synthesis are outlined. The pages are liberally illustrated with structural formulas.

Synthetic fibers include the various rayons, acetate, casein, nylon, vinyon, and saran. These developments are summarized briefly.

The chapter on synthetic resins is also in the nature of a summary of the preparation, properties, and major applications of most commercially available materials.

Simplicity of presentation combined with numerous examples and structural formulas makes this volume easy to read. The contents should be of value to those whose interests are either in the theoretical or the practical aspects of organic chemistry.

Commercial Waxes—Natural and Synthetic. Edited by H. Bennet. Brooklyn, N. Y., Chemical Publishing Company, 1944. 567 pages. Price, $11.

(Reviewed by A. R. Martin)

A rather conspicious gap in our chemical literature has been the absence of any reliable and up-to-date reference book on the properties of waxes. Of the published data on waxes, in far too many cases the grade of wax is not specified, thereby seriously limiting the value of the data. Furthermore, the published data represent but a small part of the existing knowledge of the properties of these important materials. In view of these considerations, it would seem hardly possible for any one person to prepare an authoritative treatise on the technology of waxes. It is probably for this reason that the present volume was prepared in the form of a symposium. Although a large proportion of the data is from the editor's own laboratory, valuable contributions from many other laboratories are acknowledged.

The book is not, and does not pretend to be, a scientific treatise. Theoretical discussion is avoided. It is a straight-forward compilation of facts and data. In the author's own words, it was prepared for ". . . the chemist, engineer, superintendent, purchasing agent, and student." All will find it of value. It is presented for the benefit of those who would use waxes. However, it goes beyond the scope of a mere handbook or formulary. It is more a detailed description of the waxes and their physical properties, as well as those of various mixtures of waxes.

A large number of graphs are presented showing the variation of important physical properties with temperature, percentage composition, and other parameters. Detailed treatments are given of the properties of twenty-four natural and forty synthetic waxes.

A particularly welcome feature of the data presented is the care used in specifying the grade of wax upon which the data were obtained.

The last 167 pages of this volume are devoted to a Wax Formulary organized in the manner of the Chemical Formulary. In this section are contained hundreds of recipes covering most of the important uses of waxes.

1944 Year Book of the American Association of Textile Chemists and Colorists. New York, Howes Publishing Co., Inc. Price, $3.50.

(Reviewed by Winn W. Chase)

The twenty-first edition of this reference work will prove invaluable to chemists, colorists, and others concerned with the application of dyes and chemicals to textiles. Among the data included are the latest standard test methods of the Association, a classified list of all dyes currently manufactured in the United States, a similar list of textile chemical specialities, and a bibliography of articles on textile chemistry and processing published in 1943. In addition, this edition contains reports of the Research Committee and its subcommittees.

ABSTRACTS

SERVICES AVAILABLE

Reprints of the original articles abstracted in TEXTILE RESEARCH *are often available from the publishers. Otherwise, it may be possible to secure copies of the periodicals. A list of periodicals, the abbreviations used in references to articles, and the addresses of publishers of English language publications was given on page 22 of the January, 1945, issue. Orders should be sent direct to the publishers.*

Photostat negatives of articles abstracted will be furnished to members of the Institute at a cost of 15 cents per page for pages not exceeding 7 inches in width and 25 cents per page for larger sizes up to 11½ x 14 inches. Postage will be added.

Microfilm copies and paper enlargements of microfilm may be obtained from: Microfilms Inc., 313 N. First St., Ann Arbor, Mich.; New York Public Library, New York, N. Y.; Yale University Library, New Haven Conn.; Harvard University Library, Cambridge, Mass.; and Library of Congress, Washington, D. C. Translations may also be obtained from the above sources.

It is planned to expand the abstract section and to include abstracts of new patents. The present classification by subjects will also be expanded to facilitate reference.

Subscriptions to reprints of the abstract section for the complete Volume 15, 1945, are still available to members of the Institute for a limited time. These will be printed on one side of the page for clipping and filing in a card index system. The charge for this service is $2.50.

ANALYSIS: TESTING LABORATORY METHODS

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Preparation of Anhydrides

Laboratory method for the preparation of organic acid anhydrides. Jehuda Orshansky and Eliahu Bograchov. *Chem. and Ind.* **44,** 382 (Nov. 4, 1944).

Organic acid anhydrides may be prepared by the reaction of an alkaline salt of an organic acid with sulfur and bromine. Increased purity may be obtained by fractional distillation or recrystallization. Detailed directions are given for preparation of acetic, propionic and benzoic anhydride.

Measurement of Elasticity by Means of Sound Waves

Determination of Young's Modulus of Elasticity for fibers and films by sound velocity measurements. J. W. Ballou and S. Silverman. TEXTILE RESEARCH **14,** 282–92 (Sept. 1944).

A method for measuring the modulus of elasticity of fibers and films by sonic means is described, and the results of an exploratory study of this modulus in various natural and synthetic fibers and films are given. The method is based on the equation for the propagation of longitudinal (sound) waves in elastic materials, which expresses the velocity of propagation in terms of the elastic modulus and density of the medium. The procedure involves measuring the sound velocity and calculating the modulus, using the proper density value. The modulus so calculated is characteristic of a dynamic, essentially adiabatic, high-loading rate, short-period measurement, since a sound frequency of approximately 10,000 cycles per second was used. The range of moduli for common textile materials was from 1×10^{10} to 50×10^{10} dynes per square centimeter.

Naphtol AS Absorption

The determination of the absorption of members of the brenthol or naphtol AS series on cellulose fibers. C. H. Giles. *J. Soc. Dyers and Colourists* **60,** 280–6 (Oct. 1944).

A colorimetric method of determination of arylamides of 2-hydroxy-3-naphthoic acid and related compounds has been used to determine absorption data for the naphtol AS range on mercerized cotton, linen, viscose rayon, and cuprammonium rayon. Viscose rayon and cuprammonium rayon have almost identical affinity for the respective naphtols, while mercerized cotton has lower affinity than viscose, but higher than linen or unmercerized cotton. Bleaching has very little effect on the affinity of either linen or cotton. Substantivity for any given fiber varies widely between members of the naphtol AS range and decreases with rise in temperature. The quantity of naphtol absorbed under the conditions used (30 min. at 25°C) closely approaches the equilibrium value in most cases.

Determination of Naphtol AS

A colorimetric method for determination of members of the brenthol or naphtol AS series in exhaust dyeliquors. F. R. Cropper and C. H. Giles. *J. Soc. Dyers and Colourists* **60,** 279–80 (Oct. 1944).

A new method is described for determining arylamides of 2-hydroxy-3-naphthoic acid (members of the brenthol or naphtol AS series) suitable for use with exhausted dyeliquors. The aqueous naphtol solution is diluted with water and coupled with diazotized sulfanilic acid in the presence of ethyl alcohol; a buffer of pH 7 is present and the strength of the colored azo solution

is determined colorimetrically. Alcohol must be replaced by Cellosolve and a buffer of pH 9 added for the determination of brenthol DA.

Photomicrography

Photomicrography of textiles for legal purposes. Martin H. Gurley, Jr. TEXTILE RESEARCH **14**, 366–9 (Nov. 1944).

The use of photomicrographic technique to show a series of process steps is illustrated by three-dimensional photographs of the changes which take place in fabrics during the production of a fused collar.

Resin Identification

Systematic procedure for identification of synthetic resins and plastics. T. P. Gladstone Shaw. *Ind. Eng. Chem. Anal. Ed.* **16**, 541–9 (Sept. 1944).

The general order of procedure involves five steps: (1) separation of the resin from solvents, plasticizers, pigments, dyes and fillers, (2) separation of the mixtures into individual resins, (3) classification of the individual resin by group tests, (4) identification by following the scheme for the group into which the resin falls, (5) confirmation by specific tests. The method classifies the resins into eight groups, depending upon the presence or absence of halogens, nitrogen, and sulfur, or if all three are absent, upon the saponification and acetyl numbers. Details for the separation of these groups and the identification of individual members are given in 17 tables.

Selected Ordinate Method

Selected ordinate method for interpretation of spectrophotometric data. E. I. Stearns. TEXTILE RESEARCH **14**, 326–32 (Oct. 1944).

In an effort to standardize the selected ordinates for use in interpreting spectrophotometric data to determine if camouflage samples pass U. S. Specifications 100–12, the basis of the calculation of a proposed set is presented.

Determination of Sulfates

Determination of small amounts of sulfate in cellulose nitrate and other cellulose esters. Carroll L. Hoffpauir and John D. Guthrie. *Ind. Eng. Chem. Anal. Ed.* **16**, 391–2 (June, 1944).

A method of analysis which has proved convenient and which gives reproducible results involves decomposition of the cellulose nitrate with nitric acid to which a small amount of perchloric acid is added after the initial stage of digestion. Barium chromate dissolved in dilute hydrochloric acid reacts with sulfate ions to give a precipitate of barium sulfate and an equivalent amount of chromic acid which can be determined iodometrically after the excess barium chromate is precipitated by making the solution alkaline with ammonia. This procedure determines total sulfur, but it is assumed that practically all the sulfur in cellulose nitrate is in the form of sulfate. This assumption is implicit in almost all methods for determining sulfate in cellulose nitrate and seems reasonable in view of the processes and materials used in its manufacture.

Trihydroxy-Isobutyric Acid

Trihydroxy-isobutyric acid and some of its derivatives. Harold M. Coleman with J. W. E. Glattfeld. *J. Am. Chem. Soc.* **66**, 1183–8 (July, 1944).

A new procedure for determining the rate and extent of conversion of glycerol to dihydroxy-acetone by *Acetobacter suboxydans* was developed. It was found that, in buffered solutions of optimum pH, almost 100% conversion occurred. Some new optical properties of dihydroxy-acetone crystals are reported. Trihydroxy-isobutyric acid was, for the first time, prepared from pure dihydroxy-acetone by treatment with sodium cyanide-catalyzed liquid anhydrous hydrogen cyanide followed by hydrolysis of the nitrile to the acid. Three derivatives of trihydroxy-isobutyric acid were prepared, the exact nature of which remains undetermined. Five derivatives of trihydroxy-isobutyric acid, hitherto unreported, were prepared and their more important properties determined.

Yarn Strength Determination

Yarn strength and strength variation as affected by speed of loading on the Moscrop Single Strand Tester. George W. Pfeiffenberger. TEXTILE RESEARCH **14**, 421–7 (Dec. 1944).

Tests are reported which were made in order to ascertain the effects of different loading speeds on single strand yarn strength and on strength variation. The newer type Moscrop tester with a pendulum loading arrangement was used. The results are reported not as a basis for definite conclusions but rather to stimulate interest in further studies in this field.

CHEMICAL AND PHYSICAL RESEARCH

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Absorption Spectra of Dyes

Effect of solvents upon the absorption spectra of dyes. IV. Water as solvent: A common pattern. S. E. Sheppard and A. L. Geddes. *J. Am. Chem. Soc.* **66**, 1995–2002 (Dec. 15, 1944).

Many dyes, of several different classes, *viz.*, azo- to disazo-, triphenylmethane, fluorescein, azine and polymethines and azoporphyrine dyes, exhibit marked aberrations from Beer's law in aqueous solutions. The aberrations appear to have a common pattern, deriving from a similar causation. In each class there appear also dyes of which the aqueous solutions conform to Beer's law. Examination of the conforming types indicates that the aberration is probably due to the formation of optically coupled pairs of ions, or dimers, which is not possible to the conformist dyes because of intermolecular steric hindrance. Certain examples cited of specific dyes, e.g., resorcinphthalein and tri-, diphenylmethane dyes which appear from the literature to deviate from the rules suggested, were not studied

over a sufficient range of pH. When due consideration is taken of the importance of pH for intermolecular hydrogen bond formation—e.g., with carboxylic and sulfonic groups—it is believed that such exceptions will fall in line.

Adsorption

The retention of fluids by solids. P. G. Nutting. *J. Franklin Inst.* **238**, 177–84 (Sept. 1944).

A general relation between energy of retention, pressure, and temperature has been developed by thermodynamic methods, applicable even to cases where that energy varies with the amount of fluid present. The three classes of experimental data on adsorption are reviewed, their interpretation in the light of thermodynamic theory is discussed, and relations between energy of change and phase and amount of fluid retained are deduced. Research necessary to clear up the whole field of fluid retention by solids from pure liquid to pure solid is indicated.

Control of Continuous Processes

Experiments in treating cotton batting with Hevea latex point way to control of continuous processes. Earl K. Fischer. TEXTILE RESEARCH **14**, 333–42 (Oct. 1944).

Experiments designed to determine the variables which affect the absorption and retention of Hevea latex in fibrous batting revealed that the following are of paramount importance: (a) total non-volatile content of the bath; (b) wetting time and its control through the addition of surface-active agents; and (c) squeeze-roll pressure. Although the use of Hevea latex for treating batting is not a common textile-mill process, it is believed that the résumé of the experiments will be of interest to all textile men concerned with the control of continuous operations in which a web of material is immersed in a saturating bath, subjected to pressure between rolls, and dried. 12 references.

Elasticity of Keratin Fibers

Elasticity of keratin fibers. Henry B. Hull and Martin Gutmann. *J. Am. Chem. Soc.* **66**, 1253–59 (Aug. 1944).

The stress-strain relations of human hair in pure water have been studied and reported. It is concluded that while the stress-strain behavior of hair is reproducible up to about 20% stretch, the process is essentially irreversible. The extent of stretch which leads to irreparable damage to the hair has been established. This begins at about 18% extension. A method has been devised to determine the "equilibrium" loads at which the hair fiber neither contracts nor extends. The influence of temperature on the elasticity of hair has been investigated. The elasticity of hair increases with increasing temperature in the Hooke's law region. The results obtained on other portions of the stress-strain curve are somewhat ambiguous except on the contraction limb of the 20% stress-strain loop. In this region the elasticity decreases with increasing temperature and accordingly indicates a rubber-like behavior. It is concluded that Astbury's newer structure for α-keratin is much too condensed and the suggestion is made that the principal feature of α-keratin is the close packing of successive alternate amino acid residues along the peptide chain. It is suggested that the stretching of hair from about 3 to 20% extension involves a process which resembles a thixotropic gel-sol transformation. This transformation is mainly responsible for the irreversible nature of the extension-contraction process.

Fatty Acid Sorption by Starch

Absorption of fatty acid by the linear component of corn starch. T. J. Schoch and C. B. Williams. *J. Amer. Chem. Soc.* **66**, 1232–3 (July, 1944).

The absorption of iodine by corn starch is markedly repressed in the presence of fatty acid. In the presence of 10% palmitic acid, the amount of iodine adsorbed by the linear component of corn starch falls to zero. The higher fatty acids also act as a precipitant for the linear chain fraction. The naturally occurring fats in starch are sufficient to repress the iodine adsorption so that samples must be defatted before potentiometric evaluation of iodine affinity.

Fibrous Proteins with Acids

The combination of fibrous proteins with acids. G. A. Gilbert and E. K. Rideal. *Proc. Royal Soc.* **182**, 335–46 (June 16, 1944).

An approximate titration equation is developed for the reaction between fibrous proteins and acids, in which account is taken of the valency and intrinsic affinities of the acid anions, and of the limited number of adsorption sites available for anions. The transition from soluble to fibrous proteins is traced in order to demonstrate that the main difference between the titration curves of the two types of protein arises from the difference in potential developed during the adsorption of protons.

Modification of Wool

The action of ethylene sulfide on wool. T. Barr and J. B. Speakman. *J. Soc. Dyers and Colourists* **60**, 238–45 (Sept. 1944).

The attempt to strengthen animal fibers (by increasing disulfide cross-linkages) by treatment with aqueous-alcoholic ethylene sulfide was unsuccessful, but resulted in the production of wool having a high degree of unshrinkability; the method has little practical importance. Wool fibers exposed to ethylene sulfide water vapors increased in weight and diameter, notably resisted extension and had a high resistance to milling shrinkage; this was due to polymerization of the ethylene sulfide within the fiber. 21% by weight of ethylene sulfide polymer may be deposited in human hair without increase in volume. This affords a method for determining dead space in fibers. Ethylene sulfide is unique in that it can produce unshrinkability by

two methods, viz., modifying the scaliness, and modifying the extensibility, of the wool fiber.

Linear Polymer Molecules

Equilibrium distribution in sizes for linear polymer molecules. Arthur V. Tobolsky. *J. Chem. Phys.* **12**, 402–4 (Oct. 1944).

Systems of linear polymer molecules are characterized by favorable heats of polymerization counterbalanced by unfavorable entropies of polymerization. Long chains are therefore formed and are stable at low temperatures while at sufficiently high temperature appreciable amounts of monomeric units split off. At any given temperature there exists a definite equilibrium distribution in sizes. This distribution is derived here by statistical methods and proves to be a very simple function of the heat of polymerization.

Thermodynamics of Polymers

Thermodynamics of heterogeneous polymers and their solutions. Paul J. Flory. *J. Chem. Phys.* **12**, 425–38 (Nov. 1944).

The statistical mechanical treatment previously applied to homogeneous polymer solutions has been extended to heterogeneous polymers composed of numerous molecular species differing in polymer chain length. Entropies of mixing with solvent are derived with reference to three standard states: the oriented pure components, the disoriented pure components, and the disoriented mixture of species. The entropy of mixing with respect to the last-mentioned state is identical with that previously derived neglecting polymer heterogeneity. Upon introducing a van Laar heat of mixing term, expressions for the partial molal free energies are derived. These should be reasonably correct in view of the satisfactory agreement between observed solvent activities in polymer-solvent solutions and theory, as shown by Huggins. The relationships should be useful not only in dealing with solutions, but also in equilibria involving heterogeneous polymers in the absence of solvent. The thermodynamic equations are applied to the problem of equilibrium in the range of partial miscibility for solvent-heterogeneous polymer systems. The requisites for efficient fractionation of high polymers are discussed. The efficiency of separation depends on the ratio of the volumes of the supernatant and the precipitated phases. In order to attain a high value for this ratio, very dilute solutions must be employed. The higher the molecular weight at which separation occurs the greater the dilution required for the same sharpness of separation. The free energy expressions are also applied to the formulation of equilibrium constants to be employed in reversible polymerization-degradation processes. It is shown that concentrations should be expressed in moles per unit volume in the equilibrium constant. The equilibrium state for a polyfunctional condensation, considered as a reaction between functional groups, is not affected by the polymeric nature of the reacting species; the position of equilibrium should be the same as is found for analogous monofunctional reactants under the same conditions.

Glutinous Starches

Glutinous corn and sorghum starches. Majel M. McMasters and G. E. Hilbert. *Ind. Eng. Chem.* **36**, 958–63 (Oct. 1944).

The compositions of various glutinous and nonglutinous varieties of corn and sorghum have been determined. In general, the glutinous varieties have less starch and more oil and protein than the nonglutinous. The types of glutinous corn can be easily processed for high-quality starch by a method similar to that used for making cornstarch. The adaptation of this method to glutinous sorghums containing a nucellar layer yields off-color starches. This difficulty can be largely overcome by pearling the grain to remove the pigmented layer. Varieties lacking the nucellar layer yield white starch without the necessity for pearling. Compared to nonglutinous starch, the glutinous type is more sensitive to processing conditions. Excessive grinding and increasing the concentration of the sulfur dioxide in the steeping operation tend to lower the viscosity of the glutinous starch. The gelatinization temperatures of the starch from the glutinous varieties are about the same as those of starch from the nonglutinous. Glutinous starch granules swell to a greater extent and exhibit a different structure than the nonglutinous. The viscosity of glutinous starch pastes is much higher than that of the ordinary type starch paste and is comparable to that of tapioca. Glutinous starch pastes are translucent, flavorless, and "long." Factors involved in the industrial utilization of glutinous starch as a replacement for tapioca starch are discussed.

Substantivity

An electronic interpretation of substantivity based on dye structure. Part 1—Azo dyes and their intermediates. H. H. Hodgson and E. Marsden. *J. Soc. Dyers and Colourists* **60**, 210–14 (Aug. 1944).

The structure of a number of substantive azo dyes and their intermediates is discussed from the standpoint of resonance theory and in support of the viewpoint that two necessary conditions for substantivity are—(1) coplanarity of the aromatic nuclei; and (2) the presence of conjugate chains of sufficient length and facile resonance in order to provide the necessary electron distribution for the polarities requisite for fixation of the molecule to the cellulosic material. It is pointed out that fulfillment of the above conditions is not alone sufficient to completely account for the substantivity of azo dyes.

Transmission Spectrum of Rubber

Further studies of the infra-red absorption of rubber. D. Williams and B. Dale. *J. Applied Phys.* **15**, 585–91 (Aug. 1944).

The transmission spectrum of natural rubber has been studied in the region between 1 μ and 15 μ and the effects of linear and radial stretch have been observed. Linear exten-

sion greater than 400 percent of the original length produces an increase in the C–C vibrational frequency. Both linear and radial stretch produce an increase in absorption coefficient and a decrease in reflection coefficient. The changes in absorption and reflection coefficients are greatest at short wave lengths.

Cuprammonium Viscosity

A study of the cuprammonium viscosity of cellulose using the Hoeppler Viscosimeter. W. O. Hisey and C. E. Brandon. *Paper Trade J.* **120**, 43–52 (Jan. 11, 1945).

The study was made of the Hoeppler Viscosimeter for measurement of the viscosity of cuprammonium dispersed cellulose. It was found that this instrument was very satisfactory for this purpose and has an inherent error approximately one-half as great as that of the TAPPI Standard T 206 m. The variables of the viscosity test were studied with the particular object of reducing the time required for viscosity determination. A rapid method was devised. It was found that the specific gravity of pulp dispersed in cuprammonium under TAPPI standard conditions was 0.945 instead of 0.96 as given in the standard method. It was also found that the tolerance for ammonia concentration given in T 206 m is too large for accurate work.

Vicose Rayon Manufacture

Changes in physical strength of individual cotton fibers during the viscose process. H. Hoffmann. Kunstseide u. Zellwolle **2**, 45–8 (Mar./Apr. 1944). (In German) (through *Bull. Inst. Paper Chem.* **15**, 109, Nov. 1944).

Small samples of Sakellaridis cotton were subjected to the various steps of the viscose process, care being taken to retain their fibrous structure by interrupting the steps after a certain period of time. After the cellulose has been regenerated from the various preparations, single fibers were isolated and subjected to (Schopper) dry and wet tensile strength measurements. Regeneration was accomplished by two different methods—i.e., with the Muller spinning bath and with sulfur dioxide gas. Both methods gave the same results, however. The data show that steeping aging (of the alkali cellulose), and xanthation have a surprisingly small influence upon the tensile strengths of the single fibers. The dry tensile strength decreases only slightly, unless the alkali cellulose is subjected to extremely long periods; nevertheless, the lowest relative value is 86% and thus lies considerably above the value for commercially regenerated cellulose fibers, which is about 50%. The results indicate that the essential decrease in tensile strength—which is responsible for the difference between native and regenerated cellulose fibers—occurs only when the xanthate is subjected to the dissolving process.

Water-Repellent Pyridinium Compounds

Studies in water-repellent pyridinium compounds. Ernest Zerner and Peter I. Pollak. TEXTILE RESEARCH **14**, 242–5 (Aug. 1944).

Factors affecting the efficiency of synthetic water-repellents are discussed. It is shown that slight differences in chemical structure have considerable influence on the water repellency. For example: the compound

$$\begin{array}{l} C_{17}H_{35}CONCH_2\text{—}NC_5H_5\text{—}Cl \\ \qquad\qquad\;\, | \\ \qquad\quad\;\; CH_3 \end{array}$$

gives good repellency and the compound

$$\begin{array}{l} CH_3CONCH_2\text{—}NC_5H_5\text{—}Cl \\ \qquad\qquad | \\ \qquad\;\; C_{18}H_{37} \end{array}$$

exhibits bad repellency. The difference between the two compounds is that in the first compound the long-chain fatty radical is connected with the carbonyl group, while in the second compound the hydrophobic part is connected with the nitrogen atom. The results of a series of experiments (described) indicate that unsatisfactory repellencies are obtained when the chain connecting two amide radicals contains an even number of methylene groups.

BLEACHING: DYEING: FINISHING

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Dyeing Synthetic Fibers

The dyeing of the newer rayons. C. M. Whittaker. *Chem. and Ind.* **44**, 269–71 (July 22, 1944).

The newer rayons are a challenge to the technical skill of the dyer. A thorough knowledge of all the characteristics of dyes used for them is needed. According to the author, the dyestuff manufacturers cannot escape the criticism of having been too slow in giving out information about their own individual dyestuffs. The author briefly reviews the dyeing characteristics of "Rayolanda," nylon, casein, alginate rayon, and "Vinyon." In this paper the term rayon is evidently used as a class name for all synthetics.

Formaldehyde Treatment

The HCHO treatment of textiles. Jos. Stadler. *Melliand Textilber.*, **23**, 593–7 (1942) (through *Chem. Abstr.* 1944, **38**, 6571[1]).

On evaporation on the water bath, HCHO solutions containing acid catalysts leave smaller amounts of residues than corresponding solutions without any catalysts. This is attributed to a depolymerizing action of the catalysts. Staple rayon which has been soaked in HCHO solution containing an acid catalyst and then centrifuged gives up the HCHO on soaking in water; hence in aqueous medium the HCHO does not react with the staple rayon. The reaction with HCHO takes place only after the drying of the staple rayon. The quantity of HCHO combined increases with increasing temperature, HCHO concentration and catalyst concentration. After drying, the HCHO is present on the fiber chiefly as polyoxymethylene, which reacts with the cellulose under the influence of the catalyst. In this reaction the catalyst may exert a depolymerizing influence on the HCHO. The polyoxymethylene precipitated primarily on the fiber is highly volatile even at room temperature; this

may lead to extensive HCHO losses, especially if the drying process has been very long. The view of Götze and Reiff (*C. A.* **37**, 2570[5]) that a portion of the HCHO combined with the fiber is present in polymeric form could not be confirmed.

FIBERS: YARNS: FABRICS: MECHANICAL PROCESSES

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Elastic Properties of Fibers

Elastic properties of Fibers. Anon. *Silk J. Ray. World* **20,** 35, 39 (Sept. 1944).

An interpretation is given of the stress-strain curves of ramic, viscose, acetate, silk, nylon wool, and cotton. It is pointed out that too much emphasis has been placed upon the tensile strength of fibers. Of more importance in determining the textile properties of a fiber are its elasticity and toughness. Elasticity is defined as the power of recovery from strain. Toughness is the area under the stress-strain curve, and as these coordinates are force and distance, this area is the work done in breaking the fiber. Hence the work is a function of both the load and the elongation. Emphasis on the load while ignoring the elongation is an unfortunate habit of many textile technologists. High strength-low elongation fibers are virtually useless for most textile purposes. Glass fiber is an outstanding example of this. When high strength, high elongation and good elasticity are all combined, an excellent textile fiber results. Nylon is such a fiber.

Effect of Chemical Treatments on Jute

Jute cellulose and the relation of jute incrustants to fiber and yarn strength. B. P. Ridge, A. H. Little, and J. Wharton. *J. Text. Inst.* **35**, T93–116 (Aug. 1944).

When jute is treated with the chemical reagents employed in textile purification and bleaching processes the lignin, hemicellulose and other incrusting substances are attacked and to some extent removed. The greater the extent of this removal the more is the strength of the jute diminished, particularly when the material is tested in the wet state. Removal of substantially all the lignin with retention of hemicellulose, or of hemicellulose with retention of lignin, results in low wet strength although dry strength is but little affected. Treatments that result in the partial removal of both these incrustants usually reduce both dry and wet strength, although in hot alkaline steeps such as are given in peroxide bleaching, where fiber swelling can occur and there is no pronounced removal of incrustants, dry strength may be increased above the original value owing to the closer setting of fiber on fiber that occurs as a consequence of swelling and subsequent drying. Boiling under moderate pressure with sodium hydroxide solution removes substantially all the hemicellulose but little lignin, whilst treatment with acid chlorite solutions and then neutral sulphite liquor removes the lignin but not the hemicellulose. The incrustants in jute resemble in their behaviour the starch size on a low-twisted sized cotton yarn, and, while they themselves have little tensile strength, they contribute in marked manner to the strength of the jute by cementing together the ultimate cellulose fiber bundles on which the strength fundamentally depends. In oxidation treatments commonly employed in technical bleaching they appear to have a protective action on the cellulose. Alkaline hypochlorite has mainly an oxidizing, and acid hypochlorite a chlorinating action on jute, and use of the latter in conjunction with a pressure boil with sodium hydroxide and a final oxidation bleach with alkaline hypochlorite promotes attack and removal of lignin and fairly readily allows pure white cellulose to be isolated. If the preliminary chlorinating treatment is not given, more drastic boiling at high pressure is necessary and more than one boil may be required. The characteristics of the jute cellulose are such as to suggest that the product can be used satisfactorily for the manufacture of viscose, cellulose compounds and white papers. The "browning" of bleached jute that occurs when this material is exposed to sunlight can be prevented only when the conditions of purification are such as to ensue that no lignin remains, and it appears that lignin itself is the product responsible for the browning effect.

Coated Fabrics

The story of coated fabrics. I—Development of oilcloth. Francis J. Tuttle. TEXTILE RESEARCH **14,** 228–32 (July, 1944). **II—Rubber and pyroxylin coatings.** IBID. **14,** 260–9 (Aug. 1944).

The evolution of methods for the manufacture of coated fabrics, commencing with the use of vegetable oils and leading to the use of synthetic resins, is described. 16 references.

Fiber Consumption

Trends in fiber consumption. Robert B. Evans. *Cotton* **109**, 80–4 (Jan. 1945).

An analysis of consumption of cotton and other fibers over the past 50 years.

Effect of Acid on Linen

The effect of H_2SO_4 on linen fabric. P. P. Viktorov. *Tekstil. Prom.* **4**, 17–18 (1944) (through *Chem. Abstr.* 1944, **38**, 6570[5]).

Linen was brought to boiling in solutions containing 0.5, 1.0, 1.5 and 2.5 g./l. of H_2SO_4 allowed to cool for 24 hours, washed free of acid, kept in boiling H_2O for 8 hours, washed again and dried. The respective concentrations of H_2SO_4 decreased the strength of the linen by 24.3, 27.0, 28.9 and 40.2%. Both tap water and distilled H_2O lowered the strength of the fabric to the same extent as the H_2SO_4 solutions. Boiling linen in a Na silicate solution (30° Bé.) for 2 hours decreased the strength by 10%. Boiling for 2 hours in H_2O lowered the original weight by 10%. A short boiling of the fabric in H_2O with or without chemicals conserves the strength of the fabric better than does keeping the fabric in the cooling liquid after

boiling. The use of the chemicals may be omitted entirely as far as the strength of linen is concerned. The fabric is softer if allowed to cool in the liquid in which it was boiled, particularly in the presence of an acid.

Rayon from Alginic Acid

The production of rayon from alginic acid. J. B. Speakman and N. H. Chamberlain. *J. Soc. Dyers and Colourists* **60**, 264–72 (Oct. 1944).

Alginic acid fulfils the main requirements for a substance intended for use in the manufacture of fibers. It consists of chain molecules of high mol. wt., possessing reactive side chains, and abundant supplies are readily available. Solutions of the soluble alginates, e.g. sodium alginate, are sufficiently viscous for spinning by the viscose rayon system and are readily coagulated by dilute solutions of strong acids to give filaments of alginic acid, or by salts of metals which give insoluble alginates. Alginic acid and calcium alginate rayons suffer from the defect that they are readily dissolved in a solution of soap (0.2%) and sodium carbonate (0.2%). Alkali-resistant alginates (which remain undissolved after 24 hours' treatment in the cold with soap and soda solution) have been prepared in the form of chromium (colored) and beryllium (uncolored) salts; these are most satisfactorily prepared by treating yarn spun as calcium alginate with the basic acetates of chromium or beryllium. The experimental work involved in the development of the technique by which alginate yarns of satisfactory physical properties (e.g. excellent handle and luster with a strength of about 2 grams per denier, in deniers as low as 2 deniers per filament) is detailed. Photomicrographs are presented showing cross sections of alginic acid and various metallic alginate rayons.

Cuprammonium Rayon in Hosiery

Distinctive features of cuprammonium rayon. E. H. Bemberg. *Silk J. Ray. World* **20**, 43–4 (Sept. 1944).

Primarily a discussion of the problems in the full-fashion rayon hosiery industry since the war. The chief problems were: finding a suitable treatment of yarn which would permit knitting without kinking of thread, and working with available yarns that were considerably heavier than those of silk or nylon. The stretch-spinning as used in making cuprammonium yarn makes possible the desired fine filament. The increase in the number of twists up to 40 turns or more per inch enhanced appearance by increasing sheerness and decreasing luster. It also improves resistance to snags. The effect on elasticity is doubtful.

Laundering Rayon Fabrics

The effect of wringing upon the tensile strength of rayon fabrics. D. S. Lyle and D. C. Black. *Am. Dyestuff Reptr.* **33**, 441–4, 455–7 (Oct. 23, 1944).

Five different commonly used rayon fabrics (including viscose taffeta, viscose crepe, acetate-viscose crepe, and acetate tricot knit) were subjected to fifty separate hand launderings to determine the effect of hand wringing as compared to gentle squeezing, and the effect of ironing as compared to air-drying, on the strength of the fabrics; both warp and filling were tested and both wet and dry breaking strengths were obtained. One washing method used consisted of wetting out the fabric for 3 minutes in a 0.2% solution of neutral soap in zeolite softened water at 37.7°C, squeezing suds through the fabric with cupped hands for 3 minutes, rinsing in clear water for two minutes at 37.7°C, rinsing a second time at 26°C, with gentle squeezing between rinses; the alternative washing method was identical except that in place of the squeezing the fabric was wrung by hand with a torsion pressure of 0.36 ± 0.08 foot pounds after sudsing and between each rinse. Results of all tests indicate that there is no significant difference in the strength of the rayon fabrics after hand washing whether squeezing or wringing is employed, or whether the fabric is air-dried or ironed. Graphs are presented showing the results in detail.

Rot Resistance

Study of a soil-burial method for determining rot-resistance of fabrics. D. M. Batson, D. J. Teunisson and N. Porges. *Am. Dyestuff Reptr.* **33**, 423–7 (Oct. 9, 1944); *ibid.*, 449–54 (Oct. 23, 1944).

Soil-burial methods for testing fabrics to be used in contact with plant debris, soil, and water have proved generally unsatisfactory because results were difficult to duplicate with regard to the rate and uniformity of deterioration of the buried samples. The conditions affecting the uniformity of microbial attack on soil-buried fabric samples have been studied, resulting in a modified soil-burial procedure in which rate of fabric rotting is reasonably uniform. Beds were made up of special soil consisting of equal volumes of coarse sand, clay loam soil, and well-rotted manure, and a soil temperature of 85°–90°F and a moisture content of approximately 28% maintained. Test fabrics were buried vertically by pressing one end of a 9-inch strip into the soil to a depth of seven inches with a metal blade and the surrounding soil pressed about the fabric. Both cotton and jute, when tested by this method, were completely rotted (100% strength loss) in 6 to 8 days. In the case of fabrics containing 10% copper naphthenate (equivalent to 1% copper), the period of burial required for complete rotting of cotton osnaburg was approximately 7 times, and for jute burlap 17 times, as long as for the untreated fabric. Tests showed that the soil had (a) a carbon-nitrogen ratio of 14–1, (b) a pH between 7.0 and 7.7, (c) a good available supply of nutrients needed by micro-organisms and (d) a microbial population adequate to rapidly decompose cellulose. Addition of nutrients to the soil failed to appreciably accelerate the rate of fabric rotting. It is recommended that the rot-resistance of a fabric be expressed as the ratio between

the number of days required to produce an 85% loss in breaking strength in any given fabric and the number of days' burial required to produce this amount of loss in a copper naphthenate-treated specimen of similar fabric containing 1 percent copper.

Stable Fiber Production

Stable fiber production. Anon. *Chem. and Met. Eng.* **51**, 128–31 (Aug. 1944).

The "Chem and Met Flow Sheet," a monthly feature of this journal, is devoted in the above issue to the production of rayon stable fiber. The entire process is outlined schematically and also illustrated by means of 14 photographs.

Effects of Stripping on Card Sliver Size

Effects of stripping on card sliver size. C. H. Plummer. TEXTILE RESEARCH **14**, 370–2 (Nov. 1944).

By means of the Saco-Lowell Sliver Tester, it has been possible to determine the time required for the cotton card to reach its normal condition after stripping. It appears that approximately one minute of operation is required after stripping the card before piecing up the sliver to eliminate the sections of light sliver produced immediately after stripping.

Twist Setting

Setting twist in rayon cord with high frequency heat. Anon. *Cotton* **109**, 85–6 (Jan. 1945).

A brief description of the method employed by Industrial Rayon Corporation in the application of high frequency dielectric heat to setting of twist in tire cord.

Tension Control on Slashers

Precise tension control provided by new slasher drive. Ernest J. Eaddy. *Textile Bulletin* **67**, 18–20 (Jan. 15, 1945).

A brief description of the Westinghouse multi-motor slasher drive and Rototrol tension control setting forth the advantages attained when slashers are modernized by installing the new drive and control. Stretch of No. 21 yarn was controlled to one-half of one percent; 33 yards of No. 21 yarn dried per minute; operating speeds varied between 18 and 70 yards per minute; and creeping speeds were as low as 4 yards per minute.

Weak Places in Fabrics

Weak places in cotton fabrics. Frank Kendall. *J. Text. Inst.* **35**, T117–22 (Sept. 1944).

Data are presented illustrative of the weakening effect on fabrics caused by allowing looms to stand idle with the shafts in an open position. In some of the experiments described the loss of strength observed in the fabric was as high as 40%.

Wool Resist Processes

Wool resist processes. The use of formaldehyde and its condensation products with naphthol-sulfonic acids. G. H. Elliot. *J. Soc. Dyers and Colourists* **60**, 273–8 (Oct. 1944).

A chemical resist process should block the basic side chains of wool and also introduce new acidic groups. Treatment with formaldehyde at above 100°C has been employed successfully to fulfil the first requirement. Reaction between amino-groups and formaldehyde to form methylene bridges may be responsible for the improvement in resist effect caused by heat treatment. The second resist requirement has been satisfied by the formation of condensation products of formaldehyde and certain naphthol-sulfonic acids within the wool fiber. Best results are obtained by boiling wool for 30 minutes with 10 volumes of solution containing 10% of formaldehyde, 0.5% of sulfuric acid, and 2–3% of b-naphthol 3:6 disodium sulfonate (R-salt). The material is then centrifuged, dried, baked at 110°C for 15 minutes and finally washed. The treated material has a good handle and although yarn strength is reduced, the wear-resistance is unaltered. Both convenience and economy should commend this new process for successful application on a large scale.

MISCELLANEOUS

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Aptitude Testing

Some Experiments in Aptitude Testing. Courtenay Bateman. *Cotton* **108**, 95–9 (Oct. 1944).

Methods in use at Pacific Mills for conducting aptitude tests are described. Aptitude testing at Pacific is still in the experimental stage, but it has cut training costs considerably by eliminating the "all fingers" from the "all thumbs" among prospective learners.

Corrosion of Metals

The principles of electrolytic corrosion of metals. Geoffrey E. Coates. *Chem. and Ind.* **35**, 306–9 (Aug. 26, 1944).

A review of the physical chemistry of the corrosion of metals.

Electronics

Electronics in the textile industry. James T. Meador. *Textile Bulletin* **67**, 37–8, 45 (Oct. 1, 1944).

The principles upon which the operation of electronic tubes depend are briefly outlined and the eight principal tubes for different phases of operation with their applications to textile uses are briefly described.

A. G. Green

The scientific and technical work of Professor A. G. Green, F.R.S. K. H. Saunders. *J. Soc. Dyers and Colourists* **60**, 81–93 (Apr. 1944).

A detailed account is given of Green's varied accomplishments in the field of organic chemistry from his discovery of Primuline through his work on diazotypes and Para Red, investigations in the field of sulfur dyes, development of the stilbene dyes, his notable work with Aniline Black, his research on quinonoid compounds and other problems relating color and constitution, his war work with explosives and poison gas, his experiments in chem-

otherapy, particularly sulfanilamide, and, finally, his horticultural experiments with fluorescent dyes. A complete list of Green's written work, 178 publications, is appended.

Luminous Textiles

Luminous processes used for textiles. Christopher S. Jones. *Textile Age* **8**, 86–8 (Oct. 1944).

Some methods are suggested for making fabrics and cordage luminous in the dark.

Philosophy of Research

What is research? V. G. W. Harrison. *Paper-Maker* **107**, 15–16, 36 (Midsummer Special 1944) (through *Bull. Inst. Paper Chem.* **15**, 28, Sept. 1944).

The author attempts to explain the philosophy of research and to outline the spirit which underlies it as well as the use of science. Those who hail it as a panacea for all the ills which beset the world will be disappointed. Many believed that the evil in this world was caused by material want and maladjustment of the individual or nation to circumstances, and that man's emotional and moral development would keep pace with his growth in worldly knowledge and technical advancement; they have been rudely disillusioned. Science is essentially a neutral influence; its gifts may be used for good or for ill, as men please. Science offers gifts which, properly and wisely applied, can help to make life more enjoyable and pleasant for all. Technical advancement, increase of wealth, and material power are not in themselves bad, and may be blessings if men make them their servants and not their masters. However, the scientist should not be blamed, if the fruits of his labors are misused.

Quality Control Chart Technique

The quality control chart technique in applied textile research. O. P. Beckwith. TEXTILE RESEARCH **14**, 319–25 (Oct. 1944).

Two specific examples of the use of the quality control chart are given: (1) two test methods were studied in which the control chart clearly demonstrated the superiority of one of these methods; (2) the efficiency of a carding attachment designed to improve the uniformity of roving was shown by the control chart to have no significant advantage over the card not so equipped.

Research and Technology

Technological and industrial trends. I—History of change in research and technology. TEXTILE RESEARCH **14**, 166–71 (June, 1944). II—The next twenty years. *Ibid.* **14**, 208–14 (July, 1944).

The author discusses, in the first article, changes that have been taking place in research and technology and the import of these changes upon corporate profits and corporate policies. In the second article, he draws some conclusions in regard to the future, basing his reasoning on recent trends. He concludes that the next period will witness the coming up from behind of some of the now more backward industries and arts. Another current in the mainstream of change is that research in the future is going to work more for the consumer and less for the producer. Vertical integration is discussed also the certainty of existing fabrication to reach out into neighboring fields and broaden their own industrial structure. Industrial "fence-hopping" will be very much the order of the day. The effect of technology upon corporate growth is touched upon and the research director is warned that corporate profits have two dimensions: not height alone, but area of base as well.

Textile Industry as a Chemical Market

Peacetime markets for chemicals. II. The textile industry. Douglas G. Woolf. *Chem. Industries* **55**, 218–21 (Aug. 1944) (through *Bull. Inst. Paper Chem.* **15**, 36 (Sept. 1944)).

The trend toward tailor-made fibers indicates the development of a chemical instead of a mechanical type of textile industry. The increase in synthetic fiber use and the extension of textile finishes will add materially to the amount of chemicals and dyestuffs consumed by the industry prior to the war. One of the most important factors in the expansion of the industry will be the pressure and competition from other industries, notably the paper industry. This will by far overshadow the inevitable competition between the individual fibers. The greatest threat, however, may be in the form of a new competition from the chemical industry by developing completely synthetic fibers, by some kind of extrusion, or other process which may mean the elimination of the textile industry as known today. In this sense, the chemical industry may find itself placed in the position of a supplier to, and a competitor of, the textile industry. The latter is recognizing this fact and is determined to find, through research, the answers in the postwar period. Members of the textile industry know what the absence of a research background cost them in the difficult days of the 1920's when other industries in this country were booming; they recognize that, if one industry fails to meet requirements, another industry will arise in its place.

Water Purification

Resinous ion exchange applications. Edward R. Mueller. *Paper Trade J.* **119**, 120–23 (Sept. 21, 1944).

Until the development of satisfactory resinous anion adsorbents the process of deionization, whereby water comparable to U.S.P. single distilled water is obtained, was not commercially feasible. Deionization represents an advanced step in water conditioning over the heretofore restricted applications of siliceous and carbonaceous zeolites. Moreover, the work of Adams and Holmes led to the development of resinous cation exchanges having properties, not exhibited by the zeolites, which insure higher quality treated waters. The use of deionization of water is widespread, due, in part, to the low cost. Deionization itself is not restricted to water conditioning processes alone, but can be employed in many and varied applications.